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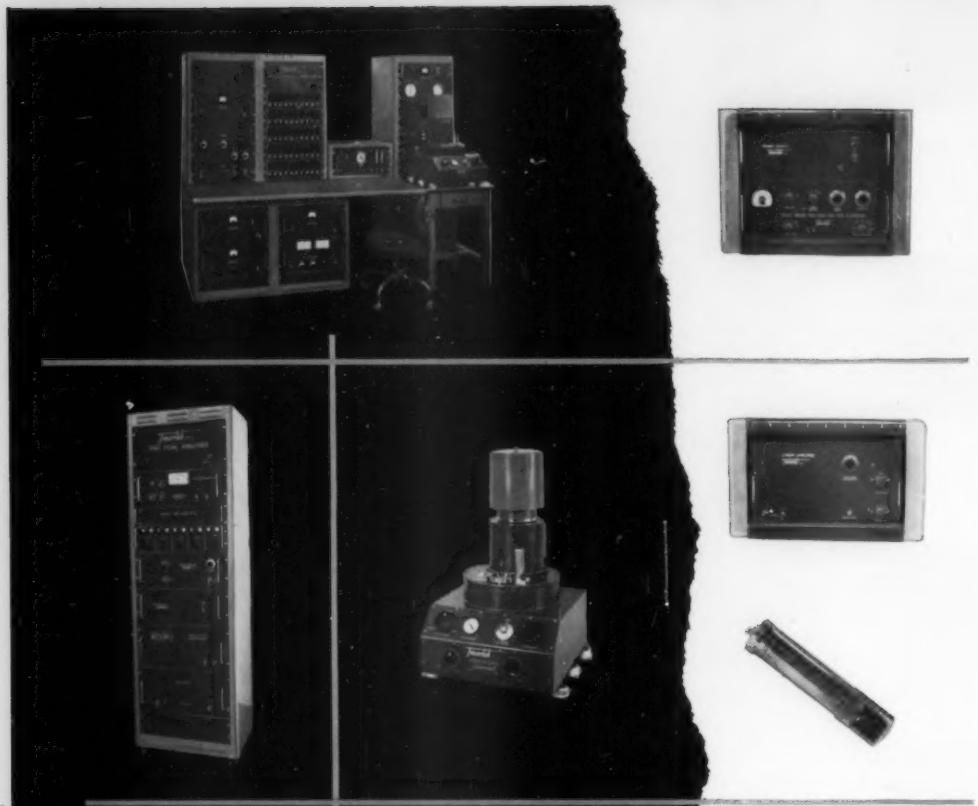

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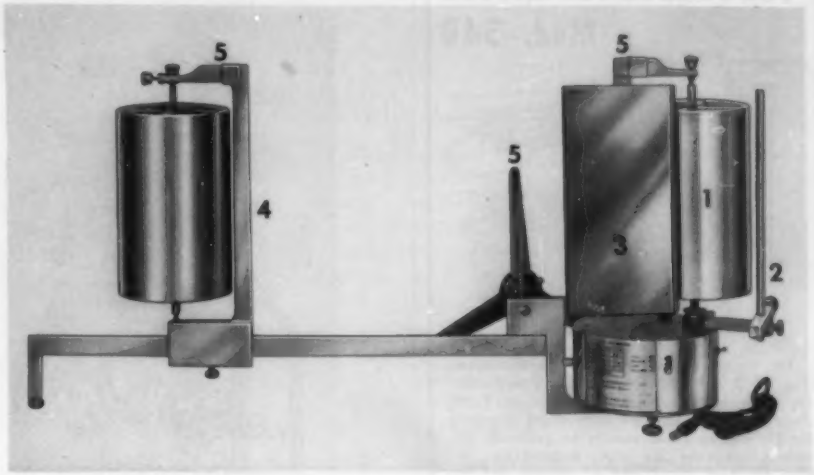

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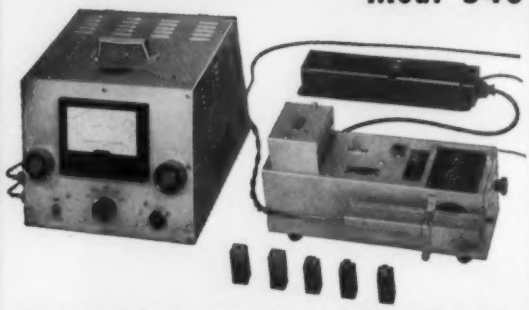

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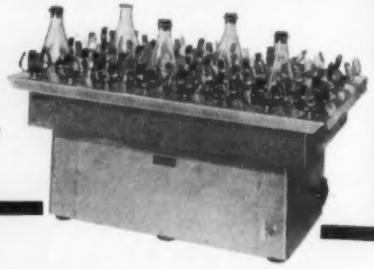

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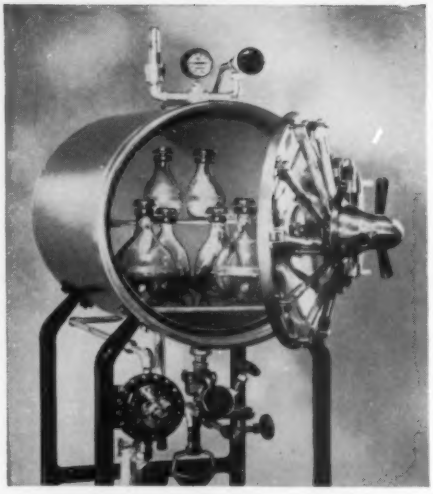

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On the Collateral Lives of Physicists

Physicists not only invent and discover; they also explain. On the one hand we are teachers, increasing the number and, we hope, the competence of our own profession. There is for us at least one great problem that is relevant to the now very prominent question of the adequacy of our profession, both in talent and in number, to the needs of the time and of our country. It is true that here much could, and something should, be said of many of the practices by which we waste ourselves and our colleagues and the treasure of their genius and learning. But this problem of communication is also relevant to the integrity of our relations with our time and our culture, with the majority of our fellows who are not physicists, and for whom we would wish that they could know something of our work and have some honest pleasure in it.

Every scientific advance, past or contemporary, has two traits: it is an enrichment of technique; it enables us to do what we could not do before, or to do it better—it is know-how. It is also the answer and reformulation of questions long agitating man's curiosity, something to contemplate, in Peirce's words, "the demi-cadence which closes a musical phrase in the symphony of our intellectual life," a thing of beauty; it is knowledge. As physics grows, and there appears to be more and more to learn, the problem of reconciling know-how and knowledge grows more urgent. We tend to teach one another, except in the golden years of graduate and postdoctoral study and apprenticeship, more and more in terms of mastery of technique, losing the sense of beauty and with it the sense of history and of man. On the other hand, we tend to teach those not destined to be physicists too much in terms of the story and too little in terms of the substance. We must make more humane what we tell the young physicist and must seek ways to make more robust and more detailed what we tell the man of art or letters or affairs.

Physicists are not only inventors, discoverers, and teachers; they are busy in almost all the practical undertakings of our technical society. I will take one field where our works have made changes of great portent for man's history. We have changed the instruments, and therefore in large measure the nature, of war. The full import of this change is surely not clear today. I know how many of you devote much of your heart and life not only to the explanation of the technical possibilities but to weighing the probable course of future development and the alternatives of policy. Yet the last decade has brought one change that we must welcome. In a measure that is in the nature of things neither complete nor adequate, the new situation has been explained to the makers of policy in particular, and to people in general. The labors of physicists in explanation and in prophecy are not and cannot be ended; and there is no standing Joint Committee on the World's Salvation to which they can abdicate their concern. Yet by now the problem of living with the new dangers and the new hopes is where it belongs: with the public and its officers, the governments. Let us be sure that by our effort and our clarity we always keep it there.—ROBERT OPPENHEIMER, *Institute for Advanced Study, Princeton, New Jersey*

This editorial is based on excerpts from an address delivered at the 25th anniversary celebration of the American Institute of Physics, 2 Feb. 1956; the address will be published in Physics Today.

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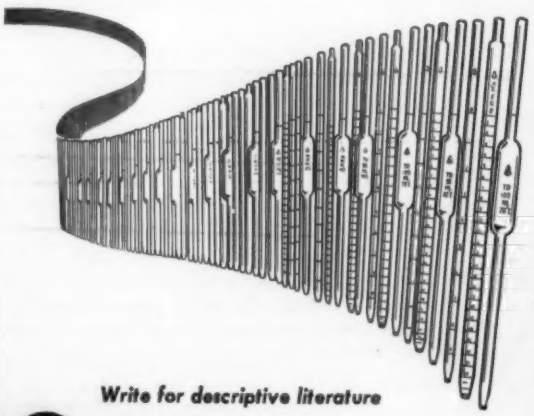

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Chemical Conversion of Solar Energy

Rudolph J. Marcus

It has long been recognized that the fossil fuels of the earth are rapidly being exhausted. The mineral fuels present in the earth, including sources of nuclear energy, are also limited. The rate at which the fossil energy sources are being replaced by photosynthesis is not sufficiently rapid to balance the energy needs of our civilization. It is therefore obvious that the energy of the sun must be used in a more efficient manner than it is in photosynthesis (*1, 2*). Man's utilization of solar energy involves consideration of the following processes.

1) *Collection of sunshine, either with or without concentration.* Any common material—particularly one having high heat capacity—will collect solar energy in the form of heat. Rocks, sand, and large bodies of water serve this purpose in nature. In a more selective fashion, the green leaf collects sunshine for a specific use. A common device for the collection of sunshine as heat is the flat-plate collector, which is used in solar air and water heaters. To concentrate solar energy—as, for instance, in solar furnaces—mirrors and lenses are usually employed.

2) *Conversion of solar radiation into other forms of energy.* Roughly half the sunlight incident on the earth's surface is in the infrared portion of the spectrum and is directly absorbed as molecular heat. The visible part of the spectrum and is directly absorbed as molecan be converted into more serviceable forms of energy in a variety of ways. For instance, in the green plant, conversion is a chemical reaction in which chlorophyll participates. In solar batteries, conversion consists of the ionization of an atom, with consequent migration of charged particles to produce an electric current. Other useful methods of conversion of solar energy include photochemical, photoelectric, and photogalvanic processes.

3) *Storage of potential energy in a readily available and convenient form.* Storage of energy depends generally on the arrangement of matter—it requires energy, for instance, to set flywheels in motion, to stretch springs, and to create reservoirs of water above sea level. Chemical potential energy is a particularly desirable kind of energy that appears in many different forms.

4) *Generation of power.* A variety of engines are known that transfer potential energy into kinetic energy.

5) *Application of power to do useful mechanical work.* Having outlined the scope of the solar energy field, I shall now focus attention on the conversion of radiant energy into chemical potential energy and will detail some of the methods by which this may be accomplished. Thus, the collection of solar energy and utilization of power fall outside the range of this paper.

The author is on the staff of Stanford Research Institute, Stanford, Calif.

Energy Storage in Nature

Biological storage of energy from the sun is primarily a chemical process. In the photosynthetic process, carbon dioxide is reduced, forming a sugar, and water is split, producing oxygen. Radiant energy produces this change, and when the resultant sugar is burned, its energy is recovered either as chemical energy in the body or as heat from wood and coal. Thus, the production of sugar, as well as its subsequent transformation to starch by the plant, is an example of the conversion of radiant energy into chemical energy and of the storage of energy in the form of a stable endothermic compound.

Although the conversion of monochromatic solar energy by the green plant under optimum conditions in the laboratory is 25 to 66 percent (*3*), the conversion of incident sunlight in the field under natural conditions is about 0.3 percent for corn and eucalyptus, 0.13 percent for wheat, and less than 0.1 percent for aspen (*4, 5*). Furthermore, the reduction of carbon dioxide can be accomplished only by the green plant cell, although preliminary reports (*6*) of the fixation of carbon dioxide by chloroplasts have appeared. A popular picture of this situation has been presented by comparing the leaf action with that of a coffee mill (*7*). In this picture, carbon dioxide and water are poured into the top of the coffee mill, and the handle is turned (which amounts to putting the energy of sunlight into the mill); sugar and oxygen then come out of the bottom of the mill. The moment, however, that one opens the mill to find out what happens inside, the evolution of products stops. The process of opening the coffee mill is equivalent to cutting open a green plant cell; because of this limitation, energy utilization by the green plant could formerly be studied only on a macroscopic scale.

It was a great advance, therefore, when Hill (*8*) found in 1937 that chloroplasts, the small chlorophyll-bearing bodies inside the green plant cell, are able to evolve oxygen from water when they are illuminated in the presence of certain ferric compounds. This photolysis of water is today known as the Hill reaction. It is carried on by isolated chloroplasts or chloroplast fragments in the presence of water and some electron acceptor, which then is reduced in place of carbon dioxide. There appears to be little doubt that the Hill reaction is closely analogous to the oxidizing half of the photosynthetic reaction (*9*).

The Hill reaction has been extensively studied on a laboratory scale. Its velocity can be measured by following the formation of three different products—

oxygen, hydrogen ion, or the reduced form of the electron acceptor (*10*). Consequently, the Hill reaction provides a useful tool in the study of photosynthesis.

Electron-Transfer Spectra

So far I have spoken mainly of the storage part of the solar energy problem. Let us look more closely now at the conversion part of the problem—the manner in which solar energy is converted into chemical energy. A perfectly general description of this conversion is that an electron transfers from one compound to another against the gradient of chemical potential. The Franck-Condon principle (*11–14*) tells us that the transfer of the electron itself is rapid compared with the nuclear motions that precede it. Thus, part of the energy required for electron transfer is used for atomic rearrangements that make the electron transfer possible (*15, 16*). The conclusion of many investigators—whose work has been reviewed by Rabinowitch (*17*), Platzman and Franck (*18*), and Orgel (*19*)—is that the energy required for such an electron transfer against the gradient of chemical potential is faithfully reflected in some region of the absorption spectrum of the species concerned—the electron-transfer spectra. Although this definition is couched in terms of electron transfer, it does not exclude conversion reactions in which the primary light absorption step appears to involve the breaking of chemical bonds. Reactions of this type have been discussed, among others, by Calvert (*20*). The remainder of this section is concerned exclusively with photochemical electron transfers that occur in inorganic species.

The absorption bands due to electron transfer frequently occur in the ultraviolet region of the spectrum. One requirement for the identification of a particular absorption peak or limit as an electron-transfer spectrum is a very high extinction coefficient—of the order of 10^4. Another requirement is that the absorption peaks for a periodic series vary as does some electronic characteristic (ionization energy or electron affinity, for instance) of that series. In the case of the halides, for instance, light absorption in the ultraviolet catalyzes the reaction:

$$X^- + H_2O \rightarrow \tfrac{1}{2}H_2 + \tfrac{1}{2}X_2 + OH^- \quad (1)$$

The difference in energy of absorption peaks of two halide ions is very similar to the difference in the sum of their electron affinities and hydration energies (*17*). Such a correlation strongly supports the identification of these absorption peaks as electron-transfer spectra. The electron transfer is known to take place in both directions—that is, from the central ion of the absorbing species (oxidative case) and to the central ion of the absorbing species (reductive case). The direction of the electron transfer appears to be a function of the electronic parameters (*21*).

Oxidative case. Some of the absorption peaks that have been identified as belonging to electron-transfer reactions of the type

$$X^n + H_2O \rightarrow \tfrac{1}{2}H_2 + X^{n+1} + OH^- \quad (2)$$

are listed in Table 1. In some of these reactions, the production of hydrogen atoms (which appear as intermediates) was proved by the formation of polymers from the corresponding monomer solution (*21*)—a process that is known to be initiated by hydrogen atoms. Table 2 lists some other absorption peaks that have been identified as belonging to electron-transfer spectra, but they have not been studied as thoroughly as those listed in Table 1.

For the halogen reactions listed in Table 1, it has been found that the quantum yield varies linearly with the hydrogen-ion concentration. This indicates that a reaction scheme of the following kind applies (*18*):

$$X^n \cdot H_2O \overset{h\nu}{\rightleftarrows} X^{n+1} \cdot H_2O^- \quad (3)$$

$$X^{n+1} \cdot H_2O^- + H^+ \rightarrow X^{n+1} \cdot H_2O + H \quad (4a)$$

$$\text{or} \quad X^{n+1} \cdot H_2O^- \rightarrow X^{n+1} + H + OH^- \quad (4b)$$

$$2H \rightarrow H_2 \quad (5)$$

Here only one water molecule out of the hydration sheath surrounding the absorbing ion is indicated specifically. It is thought that the absorption of light by $X^n \cdot H_2O$ involves ionization of the central ion X^n and removal of the electron to one of the ligands or to a nearby acceptor molecule. The state of charge separation will obviously not persist (a lifetime of 10^{-12} seconds is estimated for this intermediate, *18*), and the unstable product of Eq. 3 may then fluoresce, dismute (Eq. 4*b*), or react with a hydrogen ion (Eq. 4*a*). Discussion of the kinetics of reactions such as Eqs. 4*a* and 4*b* is presented at the end of this section.

It appears to be useful to treat electron-transfer spectra by means of thermodynamic cycles of the Born-Haber kind (*17, 22, 23*). Such a cycle was used by Platzman and Franck (*18*) in the analysis of the electron-transfer spectra of the halide ions. The term level diagram describing this cycle is shown in Fig. 1. One of the terms in these cycles is the energy $h\nu$ of the light absorbed in the electron-transfer spectrum; the only other unknown term is generally the energy difference between the reduced form of the absorbing complex and a bound electron, on the one hand, and the reduced form of the absorbing complex and a gaseous electron, on the other hand. This energy difference can be calculated by judicious choice of a model. The use of a model in which the electron is smeared out over the first few hydration layers of the absorbing species for about 10^{-12} seconds led Platzman and Franck (*18*) to a calculation of the level in the potential well to which the electron is excited. The values of the excitation energy that they calculated in this manner matched the positions of the observed absorption peaks of the halide ions.

The use of a model in which the transferred electron remains with one of the ligands in the absorbing species led to a thermodynamic cycle in which the unknown term is the difference between the free energies of formation of the two species (*24*). This energy difference is approximated on an electrostatic basis and agrees qualitatively with observed values.

Reductive case. Although the transfer of an electron to the central ion of an absorbing species has been studied much less thoroughly than the oxidative case, some absorption peaks of this type have been identified as electron-transfer spectra. Some examples found in the litera-

Table 1. Electron-transfer spectra: oxidative case—the reaction $M^n \cdot H_2O + H^+ \rightarrow M^{n+1} \cdot H_2O + H$. E^0 is the half-cell potential.

Ion	λ (A)	hc/λ (kcal/mole)	E_H^0 kcal/mole	Reference
F^-	1500	191	94	(*17, 18*)
Cl^-	1900	150	56	(*17, 18*)
Br^-	1995	143	44	(*17, 18*)
I^-	2320	123	29	(*17, 18*)
Co^{+2}	2200	130	42	(*21*)
Ni^{+2}	2200	130		(*21*)
Mn^{+2}	2250	127	35	(*21*)
Fe^{+2}	2850	100	18	(*21*)
V^{+2}	3500	81	− 5	(*21*)
Cr^{+2}	3800	75	− 9	(*21*)
Eu^{+2}	≧ 3660	≦ 78	− 10	(47)

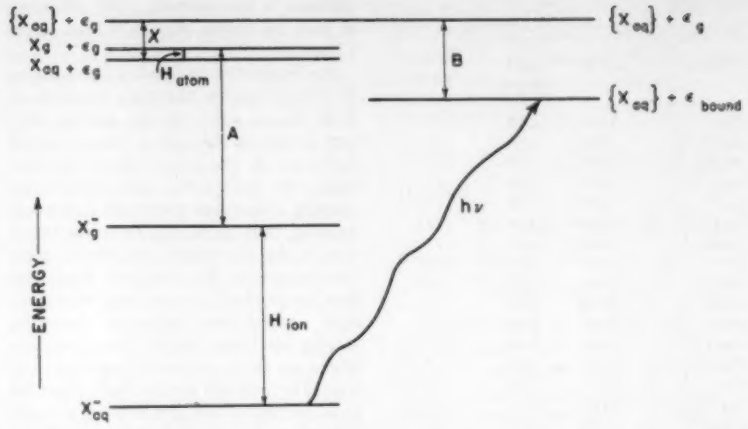

Fig. 1. Energy-level scheme for the electron-transfer spectrum of an ion in aqueous solution. [After Platzman and Franck, *18*]

ture are listed in Table 3. The initial step in these reactions always appears to be charge separation and, when water is the electron donor, the end-product is always oxygen. The reaction scheme is thus analogous to the oxidative case:

$$X^n \cdot H_2O \overset{h\nu}{\rightleftarrows} X^{n-1} \cdot H_2O^+ \qquad (6)$$

$$X^{n-1} \cdot H_2O^+ + OH^- \rightarrow X^{n-1} \cdot H_2O + OH \qquad (7a)$$

or

$$X^{n-1} \cdot H_2O^+ \rightarrow X^{n-1} + H^+ + OH \qquad (7b)$$

$$2OH \rightarrow \rightarrow H_2O + \tfrac{1}{2}O_2 \qquad (8)$$

The reduced product may in turn be used in some reaction in which its energy is permanently stored. Thus, it was found in a study of the photo-reactions of uranium ions that U^{+3}, produced by the photoreduction of U^{+4} at low temperatures, reacted in turn with the solvent to produce hydrogen (*25*). A proposal for inorganic photosynthesis along these lines has been made by Uri (*26*), using the reaction

$$Pb^{II}Cl^+ \overset{h\nu}{\rightarrow} Pb^+ + Cl \qquad (9)$$

where the course of the electron transfer was verified by initiation of vinyl polymerization by chlorine atoms. In the presence of an organic substrate that takes up chlorine atoms, the unstable metal ion Pb^+ would be able to reduce organic acids, carbon dioxide, or even water to produce hydrogen. In preliminary experiments, it was found that such a system, when it was illuminated with light of wavelengths in the region 2800 to 3200 angstroms, was able to reduce the dye Janus Green in neutral solution. The oxidation potential of the dye in neutral solution is of the order of + 250 millivolts. Similar reactions involve use of $FeCl_4^-$ as photocatalyst (*27*).

The discussion of this section has so far centered on the light absorption of complex species, which may be handled by the methods of statistical thermodynamics. Very little can be said about the kinetics of the reactions given by Eqs. 4 and 7. Alternative *b* is in each of these cases a dismutation of a transitory complex. Alternative *a*, on the other hand, is in each case an electron-transfer reaction. Various models for such electron-transfer reactions have recently been reviewed (*16, 28*).

A special case: electron-transfer reactions of chlorophyll. An interesting application of the foregoing ideas to the question of energy conversion by chlorophyll has been made by Levitt (*29, 30*). He suggests that it is the magnesium atom that is really active in photosynthesis and that any theory of the conversion of light energy into chemical energy by chlorophyll inevitably has to take the valence changes of the magnesium atom of chlorophyll into account. Levitt arrived at this suggestion by the following reasoning.

1) The organic part of chlorophyll, pheophytin, is photochemically inactive in an electron-transfer sense.

2) The absorption spectra of chlorophyll and pheophytin are quite similar, so that the presence of magnesium in chlorophyll causes no gross change in the spectrum of the molecule.

3) Comparison of the principal absorption bands of chlorophylls *a*, *b*, and *c* with the emission lines of Mg and Mg^{+1} shows a one-to-one correspondence. In particular, this comparison shows that the blue absorption band of chlorophyll coincides with Mg lines, whereas the red absorption band of chlorophyll coincides with Mg and Mg^{+1} lines.

The univalent magnesium ion is not a common chemical species in aqueous solution; its transitory existence has only recently been discovered (*31*) in the course of the anodic oxidation of magnesium. This reaction has been used as an example of the tremendous stabilizing effect of solvation (*28*). Figure 2 is a schematic diagram that shows the stabilization of the unfamiliar univalent state of magnesium by solvation. A magnesium atom from the electrode at point *A* may be ionized to form gaseous magnesium ions, as shown by the upper two curves, but may also coordinate with the solvent at the Helmholtz double layer *B* to form the stable species in solution *C*, as shown by the lowest curve. A similar coordination with the solvent will stabilize the univalent ion *D*, and the height of the barrier *E* will determine the lifetime of the univalent ion in solution.

A similar stabilization of the magnesium ions may be predicted if one considers chlorophyll as a magnesium solvated by pheophytin. Levitt postulates that the 3*s* electrons of such a structure are successively excited by light and finally pass to the electron acceptor. If this model applies, the reaction scheme of the electron-transfer reactions of chlorophyll is that of the oxidative case, which I have already discussed; the oxidized chlorophyll then reacts with water to form oxygen and to regenerate chlorophyll.

Criteria for Practical Chemical Conversion Systems

Having examined briefly the theoretical aspects of the conversion of solar energy to chemical energy, one can see that there is much to be gained by reexamining the problem of energy storage in endothermic compounds. The following requirements come to mind when one thinks about new energy-storage reactions.

1) The system must be simple. Although any energy stored represents a triumph in the effort to reduce waste of otherwise unused sunlight, the first cost of the necessary equipment must be low enough to make its use feasible, at least in energy-poor areas of the world.

2) Operation and fuel costs must be

Table 2. Electron-transfer spectra: oxidative case.

Ion	λ (A)	hc/λ (kcal/mole)	Reference
OH^-	1870	153	(*17*)
SH^-	2270	126	(*17*)
CNS^-	2240	128	(*17*)
NO_2^-	1980	145	(*17*)
UCl_6	4000	72	(*25*)

low. In effect, this means that some extremely common substance, such as air, carbon dioxide, water, or sand, must be used as the primary reactant. The green plant utilizes carbon dioxide by means of many successive oxidation-reduction equilibria, each of which returns to its original state after the reduction of carbon dioxide has been accomplished. Carbon dioxide is thus catalytically reduced by the operation of many successive cyclic systems in the green plant.

3) The fuel produced by the converting reaction must be easily separable from the reaction mixture. This means it should separate out as a solid or as a gas.

4) The fuel produced by the converting reaction must be capable of being economically used to generate electric power.

5) The proposed system should be efficient in the use of available solar energy.

The fifth point has been put last for three reasons. (i) The energy necessary to induce endergonic chemical reactions is large compared with the energies available in the greater part of the solar spectrum. Photosynthesis appears to be the chemical reaction that can take place at longest wavelength (see Table 3) (*20*). (ii) Since any energy taken from the sun is a gain, efficiency in the amount of sunlight converted in the part of the solar spectrum utilized is important only as it affects the cost of the process. (iii) The characteristics of absorption can be changed by complexing of the absorber with organic or inorganic ligands (*19*).

Utilization of Hydrogen

It appears from these considerations that one of the best energy-storing reactions would be the photoreduction of water resulting in the formation of hydrogen. The use of water as primary reactant fulfills criterion 2. The production of hydrogen, which comes off as a gas, fulfills criterion 3. The use of hydrogen as a fuel (criterion 4) is discussed in the following paragraphs, and three different methods for its photocatalytic production (criterion 1) are discussed in succeeding sections.

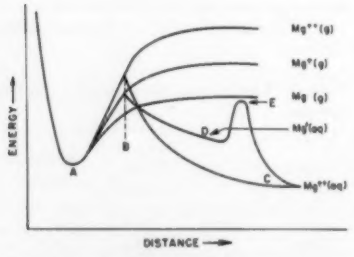

Fig. 2. Section through potential-energy surface for electrolysis of magnesium showing stabilization of ions by hydration. [After Zwolinski, Marcus, and Eyring, *28*]

Table 3. Electron-transfer spectra: reductive case.

Ion	λ (A)	hc/λ (kcal/mole)	Reference
Hg^{+2}	1800	159	(*17*)
$HgCl_4^{-2}$	2285	125	(*17*)
$HgBr_4^{-2}$	2500	115	(*17*)
HgI_4^{-2}	3230	89	(*17*)
Cu^{+2}	2000	143	(*17*)
$CuCl_4^{-2}$	2500	114	(*17*)
$CuBr_4^{-2}$	2810	102	(*17*)
Pb^{+2}	2085	137	(*17*)
$PbCl^+$	2260	127	(*17*)
$PbBr^+$	2358	121	(*17*)
PbI^+	2645	108	(*17*)
$PbCl_4^{-2}$	2720	105	(*17*)
$PbBr_4^{-2}$	3040	94	(*17*)
PbI_4^{-2}	3633	79	(*17*)
$SnCl_4^{-2}$	2185	131	(*17*)
$SnBr_4^{-2}$	2450	117	(*17*)
SnI_4^{-2}	2900	99	(*17*)
$CdCl_4^{-2}$	1875	153	(*17*)
$CdBr_4^{-2}$	2155	133	(*17*)
CdI_4^{-2}	2570	111	(*17*)
Fe^{+2}	~2300	124	(*17*)
$FeCl^{+2}$	~3200	89	(*17*)
$FeBr^{+2}$	~3800	75	(*17*)
$FeCNS^{+2}$	~4600	62	(*48, 17*)
ZnI_4^{-2}	2385	120	(*17*)
UCl_4	3000	95	(*25*)
Ce^{+4}	~3200	89	(*17*)
$Co(C_2O_4)_3^{-3}$	2450	117	(*49*)

Endothermic compounds that store solar energy have been utilized by burning. Fossil fuels such as oil and coal have been burned to produce steam, which in turn can generate electric power. Alternatively, sugars and starches made by the green plant are utilized in oxidation cycles (food for plants and animals) that are closely related to the reduction cycle of photosynthesis. It is probable that hydrogen can be used as a fuel in much the same manner that our present organic or atomic fuels are used. The characteristics of hydrogen flames have been studied by Bartholomé and Sachsse (*32*). Enough information is available today to generate power from a hydrogen-fired steam plant with an efficiency of about 30 percent (*33*)—approximately the same efficiency as a coal-burning generator. A direct way of generating power is to mount two hydrogen-burning ram jets firing in opposite directions on a rotating bar connected to a generator. Such use of hydrogen as a fuel is presently possible with an efficiency of 5 to 10 percent. Were the gas turbine to be modified to utilize hot flames, it could probably develop power from hydrogen with 20-percent efficiency. Another attractive possibility for future development is the use of hydrogen-air mixtures in an internal-combustion engine (*34–36*). Here the heat developed is no deterrent, because the burning in each cylinder is intermittent. The efficiency of such an engine may vary from 20 to 47 percent (*35*).

An interesting conversion of hydrogen to electric power has been reported of F. B. Bacon (*37*). In this process, oxygen is forced through a porous nickel electrode. At the other side of the electrode, the gas meets a continuously circulating 27-percent potassium hydroxide solution, thus producing excess hydroxyl ions in the electrolyte and leaving positive charges on the electrode. Hydrogen ions are produced at the edge of a similarly constructed hydrogen electrode, leaving electrons behind. The two electrodes are then connected to form a battery. The cell efficiencies vary from 54 to 67 percent at voltages between 0.8 and 1.0 volt and current densities of 100 to 400 milliamperes per square centimeter at 240°C and pressure of 800 pounds per square inch. Such a unit has already been operated continuously for more than 800 hours.

Production of Hydrogen

Several photochemical means of producing hydrogen appear to exist. The initiation of each of these by visible radiation is discussed in the preceding sections. These reactions will now be considered from the point of view of practicality for hydrogen production. For reference purposes, all of these reactions are gathered together in Fig. 3 in a schematic form that shows the relationship of these reactions to the oxidation-reduction potential of the initial photocatalyst, which is designated by the letter *X*.

Oxidative case. The photooxidation of both anions and cations in aqueous solution, with consequent production of hydrogen, has been well studied. These reactions seldom proceed against the gradient of chemical potential. Upon completion of the reaction, therefore, the absorbing species is in its more stable oxidation state, and considerable energy would have to be expended to reduce it again. For this reason, photooxidation of a light-absorbing species does not appear to be a good way to store energy.

This state of affairs is represented in Fig. 3 by the length of the arrow that connects the initial state of the photochemical catalyst *X* with its final state, X^+. It appears that most of these reactions take place with light absorption in the far ultraviolet, as is indicated in Table 1. Again, it is probably fair to assume that this is due to the necessity of the intermediate production of hydrogen atoms, which is endergonic by 2.1 electron volts.

Reductive case. The photoreduction of the complex ions of many elements,

with consequent production of oxygen, has been reported frequently, although the products of such reactions have not been extensively studied. These reactions proceed more frequently against the gradient of chemical potential and thus are able to store radiant energy in the form of chemical energy (*38*). This fact has been indicated in Fig. 3 by the somewhat shorter arrow leading from the initial photocatalyst X to its reduced form, X^-. The conversion of radiant energy to chemical energy represented by this reaction may not persist, however, unless the chemical energy is stored in the form of a stable endergonic compound and thus is removed from the reaction mixture. It appears that this can be accomplished when the oxidation-reduction potential of the absorbing species is more positive than the quantity

$$E = (RT/nF) \ln [H^+]$$

where F = Faraday and $E > 0.414$ at pH 7. In this case the reduced species will react with water to produce hydrogen and thus to regenerate itself. It is necessary to emphasize that this latter reaction is a thermal reaction and is not concerned with light absorption. This possibility has been indicated in Fig. 3 by the arrow pointing upward from the reduced form of the photocatalyst X. The reaction scheme in this case will be

Photoreduction

$$2X + H_2O \xrightarrow{h\nu} 2X^- + \tfrac{1}{2}O_2 + 2H^+ \quad (10)$$

Thermal oxidation

$$2X^- + 2H^+ \rightarrow 2X + H_2 \quad (11)$$

Net reaction

$$H_2O \rightarrow H_2 + \tfrac{1}{2}O_2 \quad (12)$$

The proposal of Uri for inorganic photosynthesis (*26*), which has been referred to previously, is a reaction that falls into the reductive case. In this particular context, however, the difficulty with this proposal appears to be that the initial form of the photocatalyst, which in this case is the complex ion $PbCl^+$, is not regenerated, but rather the chloride ion has been lost to some substrate. The discovery by Freed and Sancier (*25*) of the photoreduction of uranium tetrachloride also belongs to this particular reaction class. In this reaction, uranium tetrachloride was reduced to the trichloride by the action of light, and the trichloride reacted thermally with the solvent to produce hydrogen and to regenerate the oxidized form. However, this reaction was carried out in a nonaqueous solvent at very low temperatures; there is some doubt that these particular species of uranium could be maintained in aqueous solutions. Furthermore, the previous comment about losing 1 molecule of chlorine from the original form of the photocatalyst also applies here. Work on similar systems in aqueous solution is presently being carried on in this laboratory.

The requirements for the magnitude of the oxidation-reduction potential of the photocatalyst become less stringent if the reducing form of the photocatalyst is also photoactive. In this case another photoreaction may restore the original form of the photocatalyst and produce hydrogen at the same time. This is the principle that was used by Heidt (*39, 40*) in designing a system for the cyclic production of hydrogen. This system involved the photoreduction of ceric ion, which resulted in the formation of oxygen, and the subsequent photooxidation of cerous ion, which resulted in the formation of hydrogen. Heidt pictures his scheme with the following efficiencies:

Photoreduction

$$2Ce^{+4} + H_2O \xrightarrow{h\nu} 2Ce^{+3} + \tfrac{1}{2}O_2 + 2H^+ \quad \text{(36 percent)} \quad (13)$$

Photooxidation

$$2Ce^{+3} + 2H_2O \xrightarrow{h\nu} 2Ce^{+4} + H_2 + 2OH^- \quad \text{(0.1 percent)} \quad (14)$$

Net reaction

$$H_2O \rightarrow H_2 + \tfrac{1}{2}O_2 \quad (15)$$

In the laboratory study of this reaction, the 2537 line of a high-intensity mercury arc was used to photocatalyze the reaction. In ordinary sunlight, however, the efficiency of the reaction is quite low. Under the conditions employed by Heidt, several days' illumination of his absorption system by sunlight resulted in the formation of about 10^{-8} mole of hydrogen. The following difficulties come to mind in a discussion of cyclic reactions in which both halves are photocatalyzed.

1) The rates of both reactions should be the same and should be such that no appreciable photostationary concentrations of intermediates appear. Otherwise such intermediates may absorb light that is needed to make the reaction proceed. In the afore-mentioned scheme, the initial production of hydrogen is encouraged by use of very low initial concentrations of ceric ion.

2) When two ions of the same element but of different charge are present

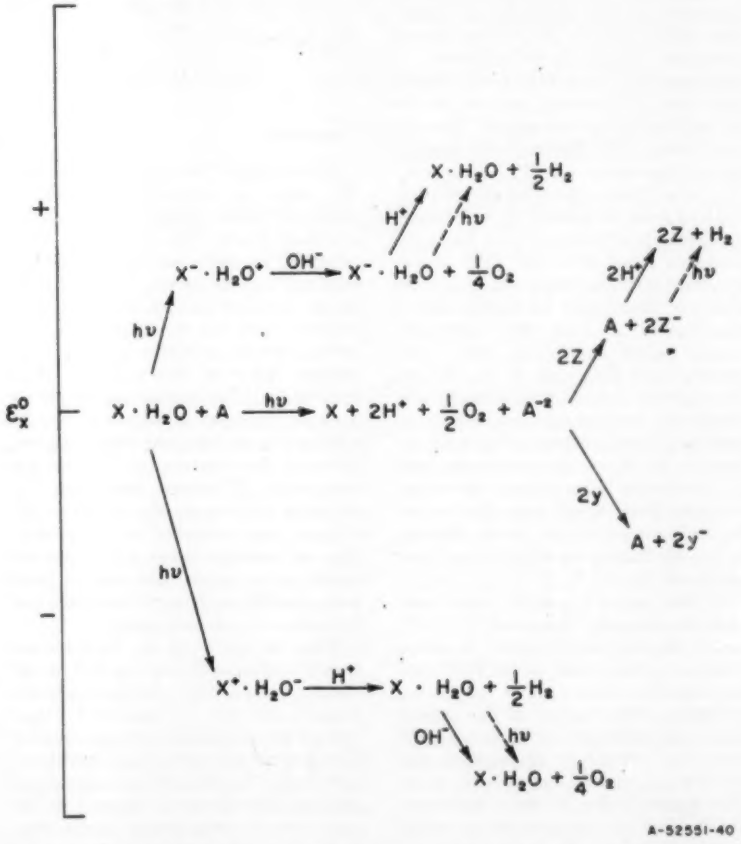

Fig. 3. Relationship of the various routes of hydrogen production to the reduction potential E_x^0 of a photocatalyst.

in aqueous solution, they will often exchange electrons. In the present case, such an electron exchange would be

$$Ce^{*+3} + Ce^{+4} \rightarrow Ce^{*+4} + Ce^{+3} \quad (16)$$

The theory of such electron-exchange reactions has been treated by several authors (*15, 16, 28*). Such exchange reactions interfere with the cyclic production of hydrogen in at least two different ways. (i) Although the actual electron transfer is fast, the atomic adjustments required by the Franck-Condon principle take time, and the ions are unavailable for hydrogen production during that time (*39*). (ii) Some electron-exchange reactions may proceed by a photocatalytic, as well as a thermal, path. The cerium exchange reaction is one of these. Gryder and Dodson (*41*) attributed the rapid ceric ion exchange in perchloric acid to an excited cerous species that lies about 2000 cm^{-1}, or 572 calories/mole, above the ground state. For the thermal reaction, one can expect from the Boltzmann probability that 10^{-3} percent of the cerous ions exist in the excited state at room temperature; this percentage will rise considerably when radiation is present. When ultraviolet light is available, even higher states may be populated, so that the electron-exchange reaction may be considerably favored over the hydrogen-producing reaction.

3) As is shown in the reaction scheme, the two photocatalytic reactions will always be *p*H-dependent in opposite ways. Thus, if the cycle cannot be run at about *p*H 7, one reaction will always be faster than the other, with a resulting disturbance of the photostationary state.

It has also been reported (*20*) that Heidt has produced hydrogen by using ferrous and ferric ions according to this scheme. In that instance, some hydrogen appears to have been evolved at 5900 angstroms, although from Tables 1 and 2 one would expect this reaction to proceed in the ultraviolet only.

(*Note added in proof*: In a private communication, L. J. Heidt (MIT) states that he has never reported that he could produce hydrogen by using ferrous ions with light of any wavelength except 2537 A.)

Hill reaction. A photooxidation that occurs in nature is the Hill reaction, which is briefly discussed in the first section of this paper. Here one may think in terms of chlorophyll donating 2 electrons, in two separate acts of light absorption, to some intermediate, which in turn passes these electrons on to an electron acceptor. This is indicated by the middle branch of Fig. 3.

The electron acceptors most frequently used in laboratory studies of the Hill reaction are ferric compounds, primarily ferricyanide. The reduction of ferricyanide to ferrocyanide is exergonic and, hence, stores none of the light energy used in the photolysis of water. This is indicated in Fig. 3 by the reaction of A^{-2} with the electron acceptor Y. It has never been determined how hard chloroplasts can "push"—that is, whether an electron acceptor can be found that will use part of the light energy for reduction and, thus, store such light energy. This can be determined in an equilibrium system by the use of electron acceptors with varying half-cell potentials. Several quinones and dyes have been used for this purpose at concentrations at which they are supposed to be nonpoisonous to the chloroplast.

Wessels (*42*) found that illuminated chloroplasts could not reduce oxidants E_0' ($E_0' = E_0$ at *p*H 6.5) greater than -40 millivolts. The value of E_0' for ferricyanide is -440 millivolts at the potassium-ion concentrations used. If the oxygen liberated by the Hill reaction is taken off immediately, however, so that back oxidation of the electron acceptor does not occur, Wessels found that dyes of E_0' as high as 100 millivolts can be reduced.

MacDowall (*43*) studied the normal potential (that is, the extent of reduction) of a series of dyes. The highest potential reached was 250 millivolts for toluylene blue, and MacDowall thinks that even this potential was not the reducing limit of the chloroplast. Vishniac and Ochoa (*44*) observed that triphosphopyridine nucleotide (TPN) can function as a Hill-reaction oxidant when its reduced form is removed by coupling to an appropriate enzyme system. Since the oxidation potential of the TPN system is about 300 millivolts, one concludes that the illuminated chloroplast has a potential of at least this magnitude. Lumry, Spikes, and Eyring (*45*), in reviewing these data, came to the conclusion that the Hill reaction is completely nonspecific (in concentrations where no oxidant-poisoning effects occur) with respect to the E_0 of the oxidant, as long as the latter is below some as yet undetermined limit. At the time of this writing, preliminary reports of the fixation of carbon dioxide by chloroplasts have appeared (*6*).

It thus appears possible that some electron acceptor, designated by Z in Fig. 3, may be found which can accept electrons in the course of the Hill reaction and thus store some of the energy evolved in this reaction. If the chloroplasts can push hard enough to reduce Z when $E_Z^0 > 0.414$ at *p*H 7, then this electron acceptor Z can in turn react with hydrogen ion to form hydrogen. This problem is currently being studied in this laboratory. The reaction can be pictured in the following manner.

Hill reaction

$$2H_2O + 4Z \xrightarrow{h\nu} 4H^+ + O_2 + 4Z^- \quad (17)$$

Thermal oxidation

$$4Z^- + 4H^+ \rightarrow 4Z + 2H_2 \quad (18)$$

Net reaction

$$H_2O \rightarrow H_2 + \tfrac{1}{2}O_2 \quad (19)$$

In an unpublished paper, Spikes (*46*) has pointed out another interesting possibility. This concerns an electron acceptor Z whose reduced form would be photoactive. Thus, another photoreaction would occur that would convert the reduced form of the electron acceptor (Z^-) back to its original form, with consequent production of hydrogen. This is the kind of reaction that would occur if, for instance, ceric ion were an electron acceptor in the Hill reaction. The reaction scheme would be, in this case:

Hill reaction

$$2H_2O + 4Z \xrightarrow{h\nu} 4H^+ + O_2 + 4Z^- \quad (20)$$

Photooxidation

$$4Z^- + 4H_2O \xrightarrow{h\nu} 4Z + 2H_2 + 4OH^- \quad (21)$$

Net reaction

$$H_2O \rightarrow H_2 + \tfrac{1}{2}O_2 \quad (22)$$

Conclusion

In this paper (*50*) I attempt to show the directions that developments in chemical storage systems of solar energy are likely to take. This is done by examining the requirements that nature and economy impose on the storage system. In the course of such an examination, it becomes clear that the simplest chemical storage system of energy is the gas hydrogen. Some of the ways in which hydrogen can be used to supply energy are mentioned briefly, together with the efficiency to be expected from each use. After a short review of the present knowledge of energy conversion (in terms of electron-transfer spectra), the various paths available for the production of hydrogen from water are discussed. It is shown that each of these paths depends on the cyclic oxidation and reduction of a photocatalyst.

Thus, a review of the fundamental concepts of light absorption and of the chemical effects that occur upon light absorption provides a comprehensive picture of the possibilities and mechanisms for conversion of solar energy into chemical energy. It can easily be appreciated that the photochemical approach to the conversion of solar energy avoids some of the thermodynamic problems that are inherent in the black-body degradation

of solar energy. It is to be hoped that this collation of available facts will encourage a quick and successful attack on this urgent problem of the storage of solar energy.

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Study Center for Behavioral Scientists

Ralph W. Tyler

The Center for Advanced Study in the Behavioral Sciences, located on a knoll a mile west of the Stanford University campus, is a place where each year 50 selected students of human behavior come on postdoctoral fellowships to study individually and with others in seeking to broaden and deepen their competence. The center was established by the Ford Foundation on the unanimous recommendation of a committee of 12 scientists and academic administrators as one major means for the further development of the behavioral sciences.

Obviously, the center is not the only important way of facilitating this development. More time and funds for research, greater attention to fundamental problems, better Ph.D. training, greater incentives for able minds to devote themselves to the study of human behavior, more opportunities for competent research workers to free themselves periodically from activities that distract them from intensive research efforts, and more encouragement in universities for interdepartmental communication on common problems would all help to speed up the development of the behavioral sciences. The center offers one kind of opportunity not previously available. For 1 year, it provides the scholar both with free time to devote entirely to his own study and with access to colleagues of the same and related disciplines who are interested in some of the same problems.

This concept of the center was outlined by a planning committee of scientists and submitted to the Ford Foundation, which in the summer of 1952 approved the proposal and appropriated $3.5 million to establish the center and to pay for 5 years of operation. The foundation also appointed a board of directors who were to incorporate the center as a nonprofit institution and to take full responsibility for it. The directors are Frank Stanton, psychologist, president of Columbia Broadcasting System, who is chairman of the board; Paul H. Buck, historian of Harvard University; F. F. Hill (*1*), economist, provost of Cornell University; Clark Kerr, economist, chancellor of the University of California at Berkeley; Robert K. Merton, sociologist of Columbia University; Robert R. Sears, psychologist, Stanford University; Alan T. Waterman, physicist, director of the National Science Foundation; and Theodore O. Yntema, economist, vice president-finance of the Ford Motor Company. The directors invited me to become executive director of the center, and I began this work on 1 October 1953. The year 1953–54 was spent in finding a site, erecting buildings, and selecting the fellows for the first year of operation, which began in September 1954. Hence comments about the way in which the center is serving the purposes intended are based on the first year of operation.

The original plan for the center con-

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templated a maximum of 50 to 60 fellowships per year with only half of that number for the first year, because of the need to work through the inevitable problems involved in launching a new institution. Actually, 36 fellowships were granted for the first year and 50 for the second. It is planned to provide 50 for each year of operation in the future. With so small a number, the selection process is highly important. It involves several steps.

Selection Process

The first step in the selection process is nomination. Letters were sent to all the behavioral science departments of accredited universities in this country and to many centers abroad explaining the purpose and plan of the center and asking for nominations of faculty members, former students, or other behavioral scientists well-known to them who were judged to be of very high competence and who would be likely to benefit from a fellowship. Individual applications were also placed in the file of nominations. Between 3000 and 4000 nominations resulted. This process will be continued in subsequent years so that scientists who have recently come to academic attention will not be left out.

The total file of nominees is then made into lists by academic fields. Each list is sent to a panel of five to seven senior scientists in that field who represent various institutions and various facets of the field and who are recognized as having wide acquaintance and high standards of judgment. Each member of the panel is asked to rate those persons on the list who are known to him in terms of the quality of their research or—for younger scholars—their promise.

There is no difficulty in getting consensus from the panel on senior nominees—that is, those over 45 years of age—who are usually full professors in universities. Also, for most of those who are in the age range 35 to 45 and are usually associate professors, a majority of the ratings are in agreement. These nominees have worked in the field long enough to have produced publications and to be generally known to their colleagues.

The juniors, on the other hand—those under 35—have not been in the field very long. Few of them have published works that have become widely known. Before they can be judged intelligently, the panel needs to have more information about them. For this purpose, we build a dossier on each nominee who is not well known to a majority of the panel. The dossier includes a personal history, copies of his publications, and ratings and comments from colleagues who know him. If these indicate great promise, arrangements are made for interviews by panel members.

Since about 2000 of the nominees are juniors, a major task of the past 2 years has been the building of dossiers that will provide adequate bases for panel judgments. Many hundreds of dossiers are still incomplete, but the task will be carried through to completion so that no nomination will fail to be acted upon carefully.

As rapidly as panels recommend nominees for fellowships, the names go to the board of directors for approval. They are then invited to come to the center at some time during its existence. As acceptances are received, the prospective fellows are asked to indicate when they will be able to come, to outline the plan of study they would like to pursue, and to name or to characterize other scientists whom they would like to have at the center and who could be of help on the study planned. The replies to this inquiry provide information for building a roster of fellows for each year.

Building the roster for a given year is largely a matching process. For example, Smith, who has been invited, has written that he will be able to come to the center in 1955–56, that he plans to work primarily on the development of language behavior, that he hopes Jones, Brown, White, and Green, or other psycholinguists, anthropologists, and neurophysiologists, can be in residence at the same time. We find that Brown and White have already been awarded fellowships and both can come in 1955–56. Furthermore, another neurophysiologist, not Green, is interested in coming to the center that year. Tentatively, then, we plan for a group studying linguistic behavior for 1955–56 that will include Smith, Brown, White, and another neurophysiologist. Further correspondence with these fellows identifies two other scientists whom they would like to work with and who have been awarded fellowships. These two can also come in 1955–56. On this basis we decide to invite the six for this year.

This type of procedure accounts for about two-thirds of the roster of fellows for a given year. The other third is made up of persons who have been awarded fellowships and can come that year but who have not developed previous connections with particular fellows. In each case, however, the plan of study involves some communication with scientists in the same and in related fields, and scientists in these fields are to be at the center during that year, so that they will be able to do some study collaboratively as well as individually.

In building the roster for a given year, consideration is also given to representation of the various fields that comprise the behavioral sciences and to a balance among the three age groups—above 45, between 35 and 45, and below 35. The roster for 1955–56, for example, includes anthropologists, economists, historians, a humanist, linguists, a logician, mathematicians, a neurologist, political scientists, psychiatrists, psychologists, sociologists, and statisticians. There are 16 who are 45 or older, 18 who are between 35 and 45, and 16 who are under 35.

Activities

The program of activities carried on at the center is a matter of continuous concern and study. The basic purpose of the center is educational—that is, to help fellows develop greater competence as behavioral scientists. There are no long-standing traditions regarding effective procedures for postdoctoral study of this sort. Hence, we have been feeling our way, seeking to examine and review carefully each activity that has been carried on.

An early decision was made not to employ an instructional staff but to emphasize mutual education, fellows learning from one another. A second early decision was made by the board of directors: the administration would not tell the fellows what they ought to study or who should teach them. The directors, largely drawn from academic institutions, agreed that, although universities were providing more time and better facilities for research than they had been a decade ago, the emphasis on specified research projects and on training students in the things that a faculty member already knew best greatly restricted opportunities for him to explore new possibilities, to round out gaps in his previous training and experience, to pursue new and untried lines of work, and to feel free from the tension of schedules and publication deadlines. Freedom in these respects was deemed the rarest and most important opportunity that the center could provide for the scientist. However, when the responsibility for the choice of activities and the development of these activities is left to each individual, he needs to know what resources are available, what activities are possible, and what values they might have.

The physical resources are generally easy to describe. The center's plant provides an individual study for each fellow, meeting rooms, a dining room, and a library. In the library, an effort is made to purchase every book or journal that the fellows expect to use frequently. This forms a working collection in the library. In addition, the center has a contract with the Stanford University library to loan materials not available in the working collection. Typewriters, calculating machines, the more common

items of I.B.M. equipment, and a room with a one-way vision screen for study of small group behavior complete the physical plant. Secretarial and research assistance are provided. The center has the facilities usually used in analyzing data previously collected and in guiding interpretations. We are prepared to arrange for other research facilities as needed; and during the past year, various studies were conducted that involved field work, opinion polls, administration of tests, and the like. However, a major question in seeking to extend research facilities of this sort relates to their value in connection with the study plans of the fellows. Obviously, the center should not duplicate expensive facilities that are already available in the universities. Furthermore, a fellow is missing the unique opportunity available at the center if he uses the year in conducting an experiment or investigation that he could do as well or better in his home institution. What we must learn is the kind and extent of facilities required to explore promising ideas and to carry on pilot studies that can guide thinking, discussion, and planning.

Although the physical resources are useful, the unique and most valuable resources of the center are the fellows themselves. Each fellow potentially might draw upon 49 others. Yet, clearly, the limitations of time would make this impossible, and not all would have major contributions to make in terms of the particular interests and needs of any one fellow. Most fellows limited their working relations to six to ten others in order not to spread themselves too thin.

In what ways can these various resources best be used for postdoctoral study? We can describe the various kinds of activities undertaken, but in only a few cases is evidence yet available concerning the relative effectiveness of a particular kind of activity. The purposes to be served, the individual habits of the person involved, and the stage of development of the idea or plan probably operate as important factors in the effectiveness of a study procedure. Reading, analyzing data previously collected, writing descriptive reports, writing interpretations of data, and writing up research plans were, of course, frequent study activities. Informal conversations were also frequent and were considered valuable by most fellows. The next most frequent activities were small working groups of two to six members, attacking a common problem, each assuming definite responsibilities in connection with the study. For example, one group worked at some length on "Social factors in perception." The relevant literature was reviewed, several previous studies were analyzed in detail, some preliminary pilot experiments were carried on, and a plan was drawn up for a more extensive investigation to be undertaken after the members of the group returned home. This working group included two psychologists and a sociologist.

Another example of work done by a small working group was the study undertaken in a Bay Area school district to identify the social forces in the community that influenced the attitudes and practices of high-school teachers of social studies. This too was a pilot investigation involving observations and interviews within the school and the larger community. Since the participants included psychologists, sociologists, and political scientists, it provided an opportunity for testing various hypotheses regarding social stratification, political power structure, and interpersonal relationships in their effects on teaching. This study will be continued on a larger scale after the fellows return to their home institutions.

Early in the planning for the center, much emphasis was placed on seminars as a type of activity considered particularly appropriate for postdoctoral mutual education. The seminar was viewed as an opportunity for 10 to 20 people to discuss one or more major problems or problem areas, to criticize alternative ways of conceptualizing and attacking the problems, to review relevant data and findings, to formulate and criticize possible interpretations of findings, and thus to organize and relate various specific studies and modes of attack into a more comprehensive formulation.

A dozen or more seminars were begun during the past year, but only three or four endured. Most of them were judged by the fellows participating to be less rewarding than the small working group. This may be inevitable or it may be that an effective seminar requires careful organization, clear assignment of leadership responsibility, the preparation of appropriate materials, and definite assignments between sessions of individual or small group efforts. In order to safeguard both freedom of individual choice and opportunity to shift efforts as a fellow saw more clearly the requirements and consequences of different activities, we depended on spontaneous interests to form seminars and developed no formal mechanism for conducting them. This year we are exploring ways of meeting the conditions required for effective seminars without greatly reducing freedom of individual choice and flexibility of individual commitments.

Another device that the center planning committee had thought would be widely useful was the short course of formal instruction. For example, several anthropologists might want to learn about projective tests—not only the theory underlying their development and use, but also specific techniques for administering and interpreting particular tests such as the TAT. A clinical psychologist at the center might be willing to give a short course on the TAT for this purpose. The planning committee mentioned a dozen illustrations of this sort as likely possibilities.

There was some use of formal short-courses at the center but not as much as had been anticipated. Anatol Rapoport of the Committee on Mathematical Biology of the University of Chicago offered to teach a refresher course in mathematics. This met for 45 minutes daily for 6 months, and about half the fellows participated. Similarly, Ralph Gerard of the University of Illinois Medical School taught a short course in biology basic to human behavior. This ran for about 4 months and involved about one-third of the fellows. Short courses on a few more specific subjects were also given—for example, latent structure analysis, the use of mathematical models, and general systems theory. The majority view of the fellows was that such courses are useful when they facilitate their broader study plans, but whenever possible, needs for this kind of specific instruction should be anticipated and such instruction should be obtained at home universities before fellows come to the center.

Frequent use of lectures was made during the first few months, calling upon both fellows and outside scholars. During the first month, the lecture schedule averaged three per week from 3:15 P.M. to 5 P.M. After that, the lectures tapered off, so that during the last 3 months there were fewer than three per month. The consensus of fellows was that the lecture is not an economical way for postdoctoral people to gain understanding of concepts, methods, or findings, except when the lecture can be focused sharply on the particular concerns of the audience. Hence, less use will be made of lectures in the future.

The experience of the first year thus indicates important values from four kinds of study activities—namely, individual work, informal conversations with other fellows, small working groups, and short courses of formal instruction dealing with definite subjects needed by the fellows participating.

Evaluation

Now that the first year is past, how is the center to be evaluated? We recognize the need for two kinds of evaluation. One purpose is to find out whether the center as an educational institution is really contributing to the development of greater competence on the part of behavioral scientists. Have the fellows actually gained greater knowledge and

understanding and more adequate skills? This will require time to ascertain. We have the works that the fellows published before they came to the center. We know the courses they taught and something of their research and teaching plans. After 1, 2, and 5 years, we shall examine the publications, the research plans, and the teaching activities of former fellows to find out how they differ from those before their center experience. Where there are differences, we shall try to find out whether and how they are related to activities carried on at the center. This will give some insights, although we cannot specify with certainty that any changes observed might not have developed without the benefit of the center experience.

A second purpose of evaluation is to guide the planning and operation of the center. Which policies facilitated productive study? Which ones interfered? Which activities were productive? Which ones were sterile? What problems were encountered by individual fellows? How were they solved? Which materials and services were helpful? Which ones were of little value? Answers to these questions can help us to improve the operations of the center. To obtain them, two procedures are being used. At the close of the year, each fellow was asked to write an evaluation of his center experience. He was guided by an outline of possible points with the following instructions: "Please comment on those points that suggest to you something worth saying, but do not feel bound to mention all of them. Please add your comments on points not included which seem important to you." These essays are very helpful in suggesting ways for improving the center program.

Some months after the fellows' return, we plan to follow up these essays with interviews and letters to get further judgments regarding center experiences and to get more detailed suggestions on points frequently mentioned in their written statements. Several comments are nearly universal in the essays. All of the fellows mentioned their great satisfaction with the year. The opportunity for free choice of study activities in an ideal physical setting was unique in their experience and highly valued. All of them mentioned the excellent library service, the fine secretarial assistance, the help they got from other fellows in criticizing papers and memoranda. Most of the younger men commented on the anxiety developed by the wide freedom available to them. They felt more keenly the responsibility for using time wisely when lack of productive effort could not be blamed on a heavy teaching load or routine responsibilities. In learning to use their freedom intelligently, many said that they discovered the insidious dangers of dissipating time and energy on trivial problems.

A majority of the essays emphasized the values obtained from working with people interested in similar problems but with quite different backgrounds of training and experience. However, several essays pointed out that interdisciplinary work requires solid links connecting the two or more scientists from different fields. Constructive efforts, they reported, required common problems and data on which to draw for questioning, analysis, and interpretation. Talking without common concrete contextual background did not get very far.

Several of the fellows commented on the "pay off" that had come from unexpected collaboration not foreseen in original plans, and they urged continuation of the policies of freedom and flexibility. Finally, most of them mentioned their eagerness to go on with work begun at the center.

There has not yet been time enough to follow up these essays, but these comments are helping to shape operations this year. The center is a new institution for the postdoctoral education of behavioral scientists. It has little tradition to guide it. If it is to be successful, it must utilize the insights and considered judgments of those who are and have been participants in this effort at mutual education.

Note

1. Mr. Hill resigned from the board of directors in September 1955 to become a vice president of the Ford Foundation.

W. D. Scott, Pioneer in Applied Psychology

Walter Dill Scott combined within himself distinction in the field of scientific inquiry, administrative ability of the highest order, a granitelike integrity, deep interest in people, and personal qualities of a most endearing character, the whole enlivened by a whimsical sense of humor.

It was my good fortune to come to know Walter Scott during the years prior to World War I when he was professor of psychology at Northwestern University and I was employment manager at the Curtis Publishing Company. When the war broke out in April 1917, he summoned to Washington a group of younger men who were active in the then new profession of "employment management," later to become known as personnel administration. I was fortunate in being a member of this group, which, under Scott's inspiring leadership, organized the Committee on Classification of Personnel in the Army. This committee planned, organized, and directed, with its military associates, the work in the Army training camps in this country and in the AEF that ascertained, so far as was then possible, the particular skills and qualifications possessed by each man being inducted into the armed forces and a military assignment in which he could use these skills and qualifications. The success of this work was due overwhelmingly to Scott's imagination and initiative and the respect he compelled on the part of military men.

When the war was over in the fall of 1918, Scott and five other members of this Army group organized a program to offer personnel consulting services to business and industrial interests. Walter Scott was the president of this group, which, borrowing his name, became known as the Scott Company. During the next few years personnel surveys were made of some 50 leading business and industrial organizations to determine in what ways the personnel situations in those organizations could be strengthened and improved, problems resolved, and morale and efficiency strengthened. After 4 years of useful and fruitful operation, the Scott Company suspended operations when Walter Scott was elected to the presidency of Northwestern University and the other members of the group transferred their energies to related work in education and industry. During the

years since then, Walter Dill Scott achieved great success as president of Northwestern University and brought added distinction to that already distinguished institution.

Others can speak of his scientific achievements better than I, and they will doubtless do so, but I will yield to none in my great admiration and affection for Walter Scott and my admiration for him in terms of the qualities mentioned in my opening paragraph. I am quite sure that all of us who worked with him during these years have felt that our association with him has constituted one of the brightest chapters in our lives.

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George Placzek, Theoretical Physicist

Last October George Placzek died in Zurich at the age of 50 after a long and painful illness. To a devoted circle of friends his death came as a terrible shock. To the world of physics it means the loss of a theoretical physicist with a universal and lucid understanding of physics, for whom the well-founded structure and significance of a theory were more important than the immediate adjustment to some recent observations.

Placzek was born in Czechoslovakia and began his scientific work in Vienna, later spending time at many of the scientific centers in Europe. He worked in Holland with Kramers, in Rome with Fermi, in Copenhagen with Bohr, in Russia with Landau. In 1938 he came to the United States and worked at Cornell University until the outbreak of World War II. He participated in the war effort, first in Montreal with the Canadian Uranium Project and later in Los Alamos; after the war he worked at the General Electric Research Laboratory for about 2 years and then spent the rest of his life at the Institute of Advanced Study at Princeton University.

Placzek's contributions to physics range over many fields. Most widely known is his work on the Raman effect during the period 1929–34. He put the theory of the Raman effect of molecules on a new basis by incorporating the classical description (as proposed by Cabannes and Rocard) into the quantum formalism. An entire science is based on the use of the Raman effect for the determination of molecular structure; the pioneer work and the fundamental ideas of these methods are mainly due to Placzek. He was the first to investigate systematically the relationships between the scattered light of a molecule and its symmetry properties. His development of the theory of scattering by molecules is a masterpiece in its generality and intrinsic beauty. It can be found condensed in a review article by him, "Rayleigh Streuung und Raman effect," in the *Handbuch der Radiologie*, ed. 2, vol. 6 (1934). His studies of the scattering of light enabled him to solve a number of problems in this field with better and more general methods than had been used before. Examples are a study on the scattering of medii at the critical point and on the scattering of crystals and liquids. In this period he acquired a mastery of the problems of scattering that made him the foremost expert in this field.

In the early 1930's, Placzek spent some time in Rome with the group around Fermi and in Copenhagen at Niels Bohr's institute. He was attracted by the newly developed neutron researches and worked experimentally and theoretically at the exploration of the fascinating problems of neutron-induced nuclear reactions. With O. R. Frisch, he published some work on the capture of slow neutrons, and, after coming to the United States for permanent residence in 1937, he joined with H. A. Bethe in the fundamental paper on neutron resonances, which gave a strong impetus to the development of our knowledge of slow neutron reactions. From then on his interest remained focused upon neutron physics. His great experience in the theory of scattering that he acquired in his earlier works was of special importance here. He became the expert in the theory of neutron scattering and in the theory of the slowing down of neutrons in matter.

When World War II broke out, Placzek naturally turned to the problems of the neutron propagation in nuclear chain reactions. He developed the most powerful methods for the treatment of the slowing down of neutrons by collision in matter and for the treatment of the diffusion of slow neutrons in matter.

The years after the war were devoted to further refinements and new developments in the theory of neutron scattering. This problem regained interest recently when the fundamental question of the electron-neutron interaction was raised. In order to identify the part of the scattering of neutrons in matter that is caused by this interaction, the theory of the scattering, elastic and inelastic, in solids and liquids had to be developed in all detail, and this was done by Placzek in his typically thorough and elegant way. Only with the help of his theories is it possible to interpret neutron scattering in crystals and liquids.

Unfortunately, Placzek did not write many papers. The style of his papers is impressive to the initiated in its elegance and conciseness, but it is hard reading for the outsider. The same was true of the few lectures that he delivered. This is why too few people know the importance of Placzek's contribution to physics and the great loss his death means for theoretical physics. The style of his thinking was true to the fine tradition of the classical period of theoretical physics, as exemplified by Rayleigh, Lorentz, and his old friend, Kramers. It is unfortunate that his long-suffered disease and his early death did not allow him many contacts with the younger generation, who do not always appreciate the value of style.

To his friends George Placzek was not only the expert in his field who was always ready to help and explain; he was a great human support to them in times of stress and difficulty. They respected him for his clear sense of values and often went to him for counsel, knowing they would find a true helper with the vast experience of a full and interesting life. They have reason to mourn his passing.

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News of Science

Swanscombe Man

Two fragments of human skull, comprising the occipital and left parietal bones, were found *in situ* in the Middle Gravels at Swanscombe in Kent, England, by A. T. Marston in 1935 and 1936. Associated with the human bones were remains of other mammals and flint artifacts of the middle Acheulian phase of paleolithic culture. Except for their unusual thickness—which, however, can be matched in modern skulls—the human cranial fragments differ in no manner from the corresponding bones of modern or sapiens man. The Middle Gravels are generally accepted as belonging to the second interglacial period, some 200,000 to 300,000 years ago. That the skull fragments are indigenous to the stratum in which they are found and do not represent the remains of a burial or other artificial instrusion is not disputed.

On 30 July 1955 J. Wymer recovered the right parietal bone of a human skull from the same stratum as that in which the occipital and left parietal were found in 1935 and 1936 [*Nature* **176**, 426 (3 Sept. 1955)]. The three bones fit each other so well that there appears to be no doubt that they belong to the same skull. Numerous bone fragments, presumably of other animals, were found with the new parietal; these have been deposited at the British Museum (Natural History) for eventual identification.

Almost 300 primary and finishing flint flakes, 4 small, primitive hand-axes typical of the Acheulian industry of Swanscombe, as well as the point of a larger, finely finished hand-axe and a magnificent flake "knife," were found during the excavation. There can be no doubt that they are contemporaneous with the skull.

The positions at which the three skull bones were discovered form the vertices of a triangle with sides of 51, 49, and 24 feet. Inside this triangle remains a mound, of which a part is definitely undisturbed gravel of the skull zone. This area is now adequately protected and is being systematically excavated.

Through the kindness of K. P. Oakley, the undersigned was privileged to examine the newly discovered right parietal at the British Museum this past August. He harbors no reasonable doubt, in view of its morphology, that the new fragment belongs to Marston's original skull discovered some 20 years earlier. Also, in company with Wymer and Oakley, the writer visited Swanscombe and was permitted to participate in a day's excavation. During that time at least one nonhuman bone and numerous flint artifacts were unearthed, some of them within a few inches of the place where the new parietal had been found.

The Swanscombe skull is of the highest importance because of its relatively great age—being exceeded in age among the fossil remains of man in Europe only by the enigmatic Heidelberg jaw; for it not only is considerably older than the classic Neanderthalers of the fourth glacial period but also older than the earlier, more generalized Neanderthalers and the fragmentary Fontéchevade skulls of the third interglacial period, which are claimed by some to represent a sapiens type of man. Because the Swanscombe fragments are indistinguishable from the corresponding cranial bones of modern man, some enthusiasts have been led to accept as an established fact the existence of a true sapiens type in Europe contemporaneous with or even antedating the Neanderthalers. However, there is an apparent low degree of correlation between the braincase, face, and jaws of men during the first half or more of the Pleistocene epoch. In view of this, the fact that for Swanscombe man not a single scrap of the braincase or jaws—not even of the frontal bone, which might yield some clue to upper facial development—has as yet been discovered, makes such a conclusion premature, to say the least.

It has recently been claimed that the Steinheim skull, which combines a Neanderthaloid face and a substantially sapiens braincase, is second interglacial in age—rather than third glacial or third interglacial as formerly believed—and thus virtually contemporaneous with the Swanscombe skull. In consequence, it has again been suggested—as it was at the time of the original Swanscombe discovery—that the missing parts of the skull of Swanscombe man would resemble those of Steinheim man and thus would be Neanderthaloid rather than sapiens [*Science* **121**, 416 (25 March 1955)]. It must again be emphasized that this is quite as much of a guess as is the attribution of sapiens face and jaws.

The solution may lie within the mound inside the triangle at Swanscombe. Since the skull fragments already recovered exhibit very little abrasion from rolling, it seems not too much to hope that Wymer and his associates may eventually come across other, critical parts of the skull, and even of the postcranial skeleton, which would definitely reveal the true nature of the Acheulian man of Swanscombe.—W.L.S., Jr.

Evaporograph

A new instrument, an evaporograph (EVA), that makes it possible to see in the dark has just been shown to the public for the first time by Baird Associates, Inc., Cambridge, an affiliate of American Research and Development Corporation. Using the device, which utilizes no electronic circuitry, a man can see a house a mile away in total darkness.

In operation the evaporograph is similar to a camera. The unit collects infrared radiation emitted from an object and focuses it as an image onto an oil film. The oil then evaporates away from point to point at rates varying with the amount of radiation received at each point. Seen in reflected light, these differences in oil film thickness appear as different colors, like oil films on water.

A detailed thermal picture of the field of view is thus obtained in color. This picture can be viewed directly or a photographic record can be made with a camera that is incorporated in the apparatus.

The unit is designed to observe radiation ranging from one to several thousand degrees F, and has a sensitivity that ranges down to about two-tenths of a degree. Accurate temperature measurements can be made either visually or photographically from this image.

EVA is housed in a cabinet 18 by 14 by 11 inches. Infrared radiation enters through a lens on one side and the operator views the oil film image through an eyepiece on the other. To date, Baird has built about a dozen of these devices for the military, each at a cost of about $9500.

The principle of operation was first demonstrated in Germany by M. Czerny. Work at Baird was originally suggested by Paul Ovrebo of the U.S. Air Force at Dayton, Ohio, and has been carried on there for the past five years. Much of the development, which has only just been declassified, was carried out under Signal Corps sponsorship. Bruce Billings, formerly research director and now vice president and general manager of Baird

Associates, was in charge of the project, and David Z. Robinson of Baird participated in the development.

Amateur Satellite Observers

The Astrophysical Observatory of the Smithsonian Institution has been assigned the task of initiating a nonprofessional satellite observation program, and Armand Spitz, director of the Spitz Laboratories, Yorklyn, Del., has been selected to act as coordinator of visual satellite observations.

Spitz will work with J. Allen Hynek, associate director of the satellite tracking program, and will supervise the coordination of the organized groups of nonprofessional observers throughout the country and the world. Among these are the Astronomical League, the American Association of Variable Star Observers, the Western Amateur Astronomers, the International Astronomical Federation, and others. Spitz will coordinate communication between these groups so that observations can be quickly transmitted to orbit computation headquarters.

Although the visual satellite observer corps will be operated on a volunteer basis, the selection of members will be based on skill and willingness to accept the responsibility for watching the sky at specified times. The principal reward to the observers will be the knowledge that their work will have unquestioned scientific value; without this assistance the satellites might be lost.

Appropriate recognition to observers who have participated in the program will be made by the officers of the satellite program so that observers will have a permanent record of their contribution. Observers who wish to participate in the satellite program should not write to Spitz directly, but should get in touch with their local amateur astronomy organizations, which will have received full instructions from central organizations.

New TB Vaccine

A new method of producing immunity to tuberculosis in mice was described recently by Guy Youmans, chairman of the bacteriology department at Northwestern University. The vaccine produced an immunity in mice equal to that found in mice immunized with BCG. BCG contains strains of living tubercle bacilli that have lost their power to produce disease, but still have the power to stimulate immune responses by the body. The new vaccine is made by grinding up tuberculosis bacteria and spinning them in a centrifuge to separate the different sized particles that are inside the cells. The particles are not alive but are still active as immunizing agents.

This is the first time that such separated, nonliving particles have been used successfully in producing immunity to tuberculosis. Chief members of the research team responsible for the development were Youmans, his wife Anne Youmans, and Irving Millman.

In the new method, tuberculosis bacteria were ground up in a sugar solution with powdered glass for 18 hours. This fragmented the membrane cover around the bacterial cells and let the inside contents escape.

The solution of suspended particles then was spun over and over again in an ultracentrifuge at speeds up to 40,000 revolutions per minute. Each time the solution was centrifuged, layers of fluid were separated and removed, until the different sized particles from within the bacteria were isolated in separate solutions or fractions.

To test whether any of these fractions could produce immunity, the investigators divided mice into three groups. One group received an injection of the fraction being tested; a second group received living BCG vaccine; and the third group received no injections. One month later the mice were infected with tubercle bacilli. Of the mice not protected, all died. Of those given BCG or the new vaccine, 60–70 percent lived.

Scientists in the News

LEON H. SCHMIDT, director of the Institute of Medical Research at Christ Hospital, Cincinnati, Ohio, has been awarded the seventh annual Eminent Chemist award of the Cincinnati Section of the American Chemical Society. The award was presented at the society's meeting on 23 Feb.

JOHN VON NEUMANN, member of the Atomic Energy Commission, recently received the Medal of Freedom from President Eisenhower. In a ceremony at the White House that was attended by Defense Secretary Charles E. Wilson and Adm. Arthur W. Radford, chairman of the Joint Chiefs of Staff, the President said that Neumann's work on "variously highly classified missions . . . resolved some of the most difficult technical problems of national defense."

WALTER H. ZINN, director of the Atomic Energy Commission's Argonne National Laboratory since 1946, has submitted his letter of resignation to the University of Chicago, which operates the laboratory. In his letter he commented: "As you know, the responsibilities as director of a research and development organization are complex and demanding. There is no reason to suppose that they will become less so in the future." He was asked to appear before the Congressional Joint Committee on Atomic Energy, but requested permission not to appear.

SIR BEN LOCKSPEISER will retire on 10 Mar. from the post of secretary to the Committee of the Privy Council for Scientific and Industrial Research, London. He is to be succeeded by H. W. MELVILLE, who is now Mason professor of chemistry at the University of Birmingham, Birmingham, England. Melville will take up his new appointment in August.

The following appointments to the faculty of the University of Michigan received approval of the regents at their meeting on 10 Feb.

HORACE W. DAVENPORT was appointed professor of physiology and chairman of the department of physiology in the Medical School, effective with the opening of the 1956–57 academic year. He has been professor and head of the department of physiology at the University of Utah College of Medicine since 1945.

THEODORE H. HUBBELL, curator of insects in the Museum of Zoology and professor of zoology, was appointed director of the Museum of Zoology, effective 12 Feb. His appointment fills the vacancy left by the death last May of Prof. J. Speed Rogers.

FRANCIS M. HENDERSON was named Fulbright lecturer in the department of engineering mechanics in the College of Engineering for 1956–57. He is senior lecturer in hydraulics in the School of Engineering, Canterbury University College, New Zealand.

JOHN C. AYRES was appointed associate professor of zoology, half time in the literary college, and half time in the Great Lakes Institute, beginning with the 1956–57 year. He also will be on a full-time basis in the Great Lakes Institute during the summer session. Ayres has been on the Cornell University faculty since 1949.

G. B. B. M. SUTHERLAND, since 1949 professor of physics and director of the Biophysics Research Center at the University of Michigan, has been named director of the National Physical Laboratory, London. Sutherland, who will take up the appointment next September, succeeds SIR EDWARD BULLARD, who retired on 31 Dec.

HOLGER ERDTMAN, Swedish chemist and expert on the chemistry of wood and wood products, visited the University of Illinois during February to deliver five talks in the annual Karl

Folkers lectures series. His wife, also a chemist, accompanied him; she is an authority on use of the spectroscope. The couple is now at the University of Wisconsin, where Erdtman is participating in a similarly endowed Folkers lecture series.

LINUS PAULING, chairman of the division of chemistry and chemical engineering at California Institute of Technology, will be George A. Miller lecturer in chemistry at the University of Illinois this spring. The lectures are scheduled for 5, 6, 12, 13, and 20 Apr. and 1, 3, and 4 May.

The late JAMES F. RINEHART, pathologist in the University of California School of Medicine, was honored by a symposium meeting of the Society for Experimental Biology and Medicine in San Francisco on 15 Feb. Henry Moon, associate professor of pathology, was chairman of the session, at which nine papers were delivered by former colleagues. Rinehart inspired much of the work that was presented, especially in the field of hardening of the arteries.

EDWARD L. SIMONS, a research associate in the analytical chemistry unit of the General Electric Research Laboratory, Schenectady, N.Y., has been selected to receive the National Association of Corrosion Engineers junior award for 1955. The award is given for the best paper published during the year in the NACE monthly periodical *Corrosion* by an author under 35 years of age. Simons' paper, "Sodium sulfate in gas turbines," dealt with metallurgical problems encountered in gas turbines that burn residual fuels. Coauthors of the paper were GEORGE V. BROWNING and H. A. LIEBHAFSKY, who are also with General Electric.

WALLACE J. MURRAY retired on 30 Dec. as an active staff member of Arthur D. Little, Inc., where he has served for 35 years. He will continue his association with the company as a consultant.

Murray received a B.S. in chemical engineering from Massachusetts Institute of Technology and a D.Sc. in physical chemistry from the University of Geneva, Geneva, Switzerland. Before joining A. D. Little in 1920, he taught at M.I.T. and at Northwestern University, was in the Chemical Warfare Service during World War I, and was employed by two chemical companies.

Murray, who holds more than 15 patents either as an individual or jointly, has cooperated on a wide variety of research projects that have involved original work with petrochemicals, pharmaceutical chemistry, and dyestuffs. He has frequently served as an expert witness in court cases involving industrial research. A charter member of the American Association of Textile Chemists and Colorists and a member of numerous professional associations, Murray is known for his translations into English of technical papers written in German, French, Italian, Russian, Swedish, Dutch, and Spanish.

W. DUNCAN RANNIE, professor of mechanical engineering at California Institute of Technology, has been appointed the institute's new Robert H. Goddard professor of jet propulsion. The Goddard professorships are the principal posts in the jet propulsion centers that were established at C.I.T. and at Princeton University by the Daniel and Florence Guggenheim Foundation. Rannie is the second Goddard professor at C.I.T. His predecessor was Hsue-Shen Tsien, who resigned last June to return to his native China.

EUGENE P. PEDERGRASS, professor of radiology at the University of Pennsylvania School of Medicine, and SAMUEL W. DONALDSON of Ann Arbor, Mich., have each been awarded the gold medal of the American College of Radiology.

JOHN A. HIPPLE, director of the Mineral Industries Experiment Station and assistant dean of the College of Mineral Industries at Pennsylvania State University, has been elected vice president and director of research of North American Philips Company, Inc. He succeeds O. S. DUFFENDACK as director of the Philips Laboratories at Irvington-on-Hudson, N.Y., and will join the staff about 1 May. Duffendack, who has reached retirement age, will continue for this year as a member of the board of directors of North American Philips and as a consultant to Philips Laboratories.

HENRY H. HAUSNER, an expert in powder metallurgy and in the construction of atomic power plants, has received the Stevens Institute of Technology Powder Metallurgy achievement award for 1956. Hausner is general manager of the Penn-Texas Corporation's nuclear engineering division.

JOSEPH J. GEORGE, superintendent of meteorology for Eastern Air Lines, Inc., has received the American Meteorological Society's first annual award for outstanding contributions to applied meteorology. Established by the Weather Corporation of America, the $500 award will be made yearly to acknowledge acheivement either in the direct application of meteorological or climatological knowledge to the fulfillment of industrial or agricultural needs, or in the research and development of scientific knowledge that can meet such needs. The prize may be awarded to any professional member of the society.

Hughes Aircraft Company has announced the appointment of two physicists to the staff of its Research and Development Laboratories. They are JOHN W. CLARK, former director of the nuclear electronics division of Litton Industries, Inc., and SAMUEL W. LICHTMAN, who has been head of the missile laboratory division of the Naval Ordnance Laboratory, Corona, Calif.

LYNN S. BEEDLE, chairman of the structural metals division at Lehigh University, has been named recipient of the first research award of the American Society of Civil Engineers. The award is given in recognition of "experimental and theoretical investigations into the fundamental nature of residual stress in structural steel."

ALBERT W. FRIEND, technical consultant of Bala-Cynwyd, Pa., received the second annual award of the National Electronics Conference last fall for his paper "The use of powdered iron in television deflecting circuits," which was presented in 1946. This work was judged a contribution of major importance to the advancement of electronics.

Recent Deaths

EDWIN J. BEVAN, Ventnor, N.J.; 73; retired mechanical engineer for the Bethlehem Steel Corporation; 8 Feb.

CLINTON T. BISSELL, Montclair, N.J.; 82; retired civil engineer; 16 Feb.

GEORGE W. BRAINERD, Pasadena, Calif.; 47; associate professor of anthropology at the University of California, Los Angeles; authority on early civilizations of Mexico; 15 Feb.

ELDRIDGE H. CAMPBELL, Loudonville, N.Y.; 55; chairman of the department of surgery at Albany Medical College; neurosurgeon who contributed much to the surgery of intracranial aneurysms; 15 Feb.

FREDERICK GAY CARTER, Shaker Heights, Ohio; 67; former president of the American Hospital Association and leading authority in hospital administration; 19 Feb.

H. HOLLAND DE JONG, Osawatomie, Kans.; 61; director of research and education at Kansas State Hospital; internationally known for his research in producing symptoms of mental illness in animals; 16 Feb.

EDWARD J. KENDRICKS, San

Antonio, Tex.; 56; commandant of the Air Force School of Aviation Medicine; 17 Feb.

EDWIN A. LAWRENCE, Indianapolis, Ind.; 45; professor of surgery and cancer research at the Indiana University School of Medicine; 21 Feb.

JAMES B. MACELWANE, Saint Louis, Mo.; 72; geophysicist and dean of the Saint Louis University Institute of Technology; president of the American Geophysical Union; organizer of the Jesuit Seismological Association; vice president of AAAS section E in 1934; 15 Feb.

MEGHNAD SAHA, Calcutta, India; 62; nuclear physicist; director of the Nuclear Physics Institute; dean of science at Calcutta University; 16 Feb.

HANS J. SCHWARTZ, New York, N.Y.; 79; professor emeritus of dermatology at Cornell Medical School; 15 Feb.

MICHAEL M. WASSERMAN, New York, N.Y.; 73; assistant bacteriologist at Beth Israel Hospital; 20 Feb.

ROLLAND J. WHITACRE, Cleveland, Ohio; 46; president of the American Board of Anethesiology and an internationally known specialist in that field; 16 Feb.

ALFRED M. WYMAN, Lebanon, Conn.; 78; retired civil engineer; 14 Feb.

Education

■ DePaul University, in cooperation with Illinois Institute of Technology, has introduced a combined liberal arts-engineering program. The 5-year program, which will lead to the degrees of bachelor of arts and bachelor of science in engineering, begins next September.

■ Seven professional master's degrees in engineering have been authorized by the Cornell University trustees and will be offered by the Cornell Graduate School in a program beginning next fall. Through an engineering division in the Graduate School, Cornell will grant master's degrees in chemical, civil, electrical, industrial, mechanical, and metallurgical engineering, and in engineering physics. The university will continue to grant M.S. and Ph.D. degrees in engineering.

The professional programs are aimed especially at two groups—graduate engineers employed in industry, and outstanding students just finishing engineering school. For admission a student must hold a bachelor's degree from a recognized school of engineering or science, or have completed 4 years in Cornell's College of Engineering.

A newly created engineering division of the Graduate School, consisting of the graduate faculty in engineering, will have general control over the advanced professional degree work. Each student will work out his program with a faculty adviser in his particular division of interest. Information on the program may be obtained from the Graduate School, Day Hall, Ithaca, N.Y.

■ Physicians from all over the United States are invited to attend an Armed Forces Institute of Pathology postgraduate course on diseases of the heart to be held in Washington, D.C., 14–17 May. The course will be open to a total of 425 civilian and armed services physicians. Civilians who desire to attend may apply to the Director, Armed Forces Institute of Pathology, Washington 25, D.C. Medical men in the armed forces should apply through normal military channels.

■ The American Chemical Society's Examinations Committee has announced two new tests for the 1956 testing program. A new test in organic chemistry, Form MB, has been prepared by the Organic Subcommittee under the chairmanship of Bernard A. Nelson, of Wheaton College. This is a test for the brief courses usually given in one semester.

The General Chemistry Subcommittee under the chairmanship of Donald D. Wright, of Brooklyn College, has prepared a new test in general chemistry, Form M. It consists of a section on information, one on application of principles, and one on equations and problems.

Further information and copies of all the tests may be obtained from Theodore A. Ashford, St. Louis University, St. Louis 4, Mo. These tests are available to members of the faculty of higher educational institutions. Please use official stationery and use the official channels of the college when making inquiries. A limited number of copies of older examinations is also available.

■ A tracer laboratory is being established in Cornell University's zoology department with the help of a $20,000 grant from the National Science Foundation. William A. Wimsatt and his assistants will use the laboratory for detailed studies on the physiological make-up of bats and other mammals. The grant will contribute toward laboratory equipment and a 3-year research program.

One special piece of equipment, designed by Wimsatt, is a portable "cave" for hibernating bats that has a separate section for subjects that have been injected with radioisotopes. The insulated box will have the same 40-degree temperature and high humidity as the natural cave environment. Other laboratory equipment will include Geiger and scintillation counters, facilities for storing radioactive material, and a darkroom for developing autoradiographs.

The Cornell laboratory will be used to study several problems concerning hibernating mammals that have never been thoroughly investigated. One project will be devoted to the connection between the bat's superior resistance to radiation damage and its low metabolic rate during hibernation. Other studies will be on the development of thyroid function in the unborn bat and on the way pregnant mammals transmit immunity against diseases to their offspring.

■ The University of Maryland has announced that the Institute of Acarology's summer session will be held 16 July–3 Aug. The course provides an opportunity for entomologists, parasitologists, zoologists, and advanced biology students to study mites and ticks. For information write to G. Anastos, Department of Zoology, University of Maryland, College Park, Md.

Grants, Fellowships, and Awards

■ The Leukemia Society, Inc., will award grants to support research projects on leukemia for the year 1956–57. Various amounts will be awarded depending upon the requirements of the investigators.

Applications may be made throughout the year; however, in order to be reviewed at the meetings of the selection committee that will take place on 1 June and 1 Sept. they should be received *not later than 15 May* and *15 Aug.*, respectively. For information, write to the Leukemia Society, Inc., 67 Wall St., New York 5.

■ The most serious difficulty encountered by the Russell Sage Foundation in its work for more effective collaboration between the social sciences and the professional services is the scarcity of trained personnel. In order to help meet this shortage, the foundation offers postdoctoral residencies in operating agencies or professional schools for the purpose of providing qualified sociologists, social psychologists, and anthropologists with specialized training and experience relevant to professional practice in health or welfare.

Applicants are eligible for consideration for appointment if they (i) have received the doctorate or will have completed all requirements for the doctorate in sociology, social psychology, or anthropology before the date on which the requested residency is to begin; (ii) are not more than 35 years of age; (iii) have records that clearly indicate superior ability; and (iv) are definitely interested in careers involving behavioral

science and professional practice in either health or welfare.

Appointments are made for one year with the possibility of renewal for one additional year. Awards may be made at any time during the year. Stipends range from $3500 to $5000.

The letter of application should explain in some detail the nature of the candidate's interests in a career of the kind indicated and the experience and training desired. The details of the work program and location of the residency requested need not be specified in the letter of application but will be arranged in the case of successful candidates in consultation with the foundation staff.

A brief biographical statement that includes the candidate's place and date of birth, marital status, educational record, employment experience, and titles of his published writing should be enclosed with the letter of application. The names and addresses of three to five persons from whom the foundation may request letters of reference should be given. Applications and requests for further information should be addressed to the Russell Sage Foudation, 505 Park Ave., New York 22.

■ Opportunities for training in the field of biostatistics leading to degrees up to the doctorate have become available through grants awarded by the National Heart Institute of the Public Health Service to departments of biostatistics in several schools of public health. With these grants the departments of biostatistics are able to offer stipends covering tuition and subsistence to acceptable candidates. The amounts of the stipends will vary with the qualifications and circumstances of the applicants.

Recipients of the awards will be expected to complete a course of study concerned with the application of statistical theory to research in biology, medicine, and public health. The background and interests of the student will determine the nature of the courses to be taken.

Additional information may be obtained from the departments of biostatistics in the schools of public health of the University of California, Berkeley; Columbia University; Harvard University; Johns Hopkins University; University of Michigan; University of Minnesota; University of North Carolina; University of Pittsburgh; and Tulane University School of Medicine.

■ The Menninger Foundation, Topeka, Kan., has available several postdoctoral fellowships in psychology. Stipends range from $3900 to $4800. In some cases $350 dependency allowances are also offered. The application deadline for the clinical research fellowships is *1 May*.

■ A special course on "Recent developments in physical science," with a correlated course on "The teaching of science," will again be offered for secondary-school science teachers by the Harvard Summer School and Graduate School of Education. Twenty DuPont fellowships of $400 each are available for these courses, which will last from 2 July to 15 Aug. The courses are open to any interested and qualified teachers, whether or not they receive one of the fellowships.

In addition to these courses for secondary-school teachers, there will be a course on "Science in the elementary school" for teachers and supervisors on the elementary level. Teachers interested in applying for one of the fellowships may obtain an application blank from the Harvard Summer School, 2-N Weld Hall, Cambridge 38, Mass.

■ The American Chemical Society's division of history of chemistry has announced the establishment of the first national award for outstanding service in the field of the history of chemistry. The annual prize, which initially will comprise $250 and a scroll, will be known as the Dexter Chemical Corporation Award in the History of Chemistry.

Selection of the recipient will be made by a three-member committee appointed by the chairman of the division. Among the types of contribution to the field that will be considered are the publication of a book or article on chemical history or furtherance of the teaching of the history of chemistry.

In the Laboratories

■ The Corning Glass Works has announced establishment of a refractories division. The new division will consolidate the development, manufacture, and sale of conventional refractories, special high-temperature refractories and Corning Glascast mold material for precision casting of metal alloys.

■ An industry-Government commercial evaluation program of an irradiated food product for civilian and military markets is being directed jointly by the Army Quartermaster Corps and AMF Atomics, Inc., subsidiary of American Machine and Foundry Company, under a joint-agreement contract with the Quartermaster Food and Container Institute (Chicago) for the Armed Forces. Under the program several groups, coordinated by AMF Atomics Inc., will evaluate the application of gamma radiation to potatoes.

Some 70,000 pounds of potatoes, comprising a selection of several varieties from both Maine and Idaho, will be irradiated at the Atomic Energy Commission's materials testing reactor at Idaho Falls, Idaho. The potatoes, before and after irradiation, will be shipped, handled, and stored under normal commercial conditions.

■ Completion of a new office building and test laboratory for research in gas turbine engines has been announced by Solar Aircraft Company, San Diego, Calif. The expansion was necessary because Solar has increased its engineering staff by 50 percent in the last year. Still more engineers are needed for the company's growing design and development programs.

■ A series of technical data bulletins on several classes of molybdenum chemicals is being prepared by Battelle Memorial Institute, Columbus, Ohio, under commission from the Climax Molybdenum Company. These bulletins will report the properties, methods of preparation, and applications of the following compounds: organic complexes of molybdenum, molybdenum disulfide, heteropolymolybdates, cyanomolybdates, and halides and oxyhalides of molybdenum.

Miscellaneous

■ *The American Journal of Digestive Diseases,* which has been published since its founding in Fort Wayne, Ind., has been sold to Paul B. Hoeber, Inc., medical book department of Harper and Brothers. The new publishers began issuing the monthly clinical journal in January. It has appeared in a new format, under the supervision of a new editorial board that is headed by Henry Janowitz, chief of gastroenterology, Mount Sinai Hospital, New York, and Maxwell H. Poppel, chief of radiology at Bellevue Hospital, New York.

■ *International Atomics,* a bulletin service on commercial atomic energy developments, has recently been introduced by Whaley-Eaton Service, news analysts of Washington, D.C. The new report is issued twice monthly to business and Government clients. Information about *International Atomics* may be obtained from Whaley-Eaton Service, Munsey Bldg., Washington 4, D.C.

■ The Research Committee of the American Sociological Society has available a *1956 Census of Research* that lists all current projects reported, together with the names of the members of the society working on each project. The 65-page document may be obtained for $1 a copy from the American Sociological Society, New York University, Washington Square, New York 3.

Reports and Letters

Occurrence of D-Glyceric Acid in Tobacco Leaves

The recent discovery (*1*–*3*) in leaves of enzymes that catalyze the dehydrogenation of the D-enantiomorph of glyceric acid again raised the question of the occurrence of free glyceric acid in the leaves of higher plants. D-Glyceric acid has been isolated from cress seedlings (*4*), but the numerous reports of glyceric acid in leaves of other plants have been based almost entirely on chromatographic evidence. The present report describes the isolation of D-glyceric acid from mature green leaves of *Nicotiana tabacum* var. Connecticut shade-grown and gives chemical proof of its identity and configuration.

The preliminary separation of glyceric acid was carried out by a modification of previously described techniques (*5*). A water extract of 15 g of dried green tobacco leaves was added to a column of Dowex 1-X10 (200 to 400 mesh, acetate form) (*6*) 12 cm by 3.5 cm². The column was washed with water, and the organic acids were eluted with 1*N* acetic acid. Fractions of 5-ml volume were collected, their composition being established by paper chromatography of small aliquots (*5*). Glyceric acid was eluted in the region of fraction 60. Appropriate fractions were pooled to give a solution that contained glyceric acid, acetic acid, and only one other contaminating acid. This solution was evaporated to dryness at 45°C in a stream of air (*5*), and the residue was dissolved in 1 ml of water.

Further purification of the glyceric acid was accomplished by partition chromatography (*7*) of this fraction. The solution was dried in small portions on a blotter disk (*7*), and the disk was placed on the surface of a column 2.1 cm in diameter that contained 25 g of silica gel. Glyceric acid was eluted with a mixture of equal volumes of chloroform and *n*-butanol equilibrated with 0.5*N* H_2SO_4. Fractions of about 10-ml volume were collected. The contaminating acid was not eluted under these conditions. The glyceric acid peak was located in the region of fraction 30 by titration of small aliquots of the effluent, and the appropriate fractions were pooled. These fractions contained chloroform, butanol, and a small quantity of sulfuric acid in addition to glyceric acid. The organic solvents were removed by distillation to a small volume in a vacuum, water was added, and the solution was neutralized with barium hydroxide. The barium sulfate was removed, and barium glycerate was then precipitated by the addition of 3 to 4 vol of alcohol. The white precipitate was collected by centrifugation and dried in a vacuum.

The yield at this point, based on titration of the fractions from the silica gel column, was approximately 72 percent. It is difficult to assess the over-all yield, since a reliable technique for determining glyceric acid in water extracts of plant tissue is not available. However, a reasonable estimate is about 50 percent.

The barium glycerate exhibited the same qualitative chromatographic behavior on ion-exchange columns (*5*), on filter paper (*5*), and on partition columns (*7*) as authentic calcium glycerate. A sample of the isolated material yielded the characteristic deep blue color when it was treated with the naphthoresorcinol-H_2SO_4 reagent of Feigl (*8*).

A portion of the barium glycerate from tobacco leaves was converted to sodium glycerate by passage of a solution through Dowex 50-X8 (*6*) in the sodium form, and the *p*-phenylphenacyl ester was prepared (*1*). It melted at 145° to 146°C. The derivative of a known sample of D-glycerate melted at 144° to 145°C, and a mixture showed no depression of the melting point.

The specific rotation of barium glycerate isolated from tobacco, measured in 6-percent ammonium molybdate (*9*), was $[\alpha]_D^{20} = +94°$ (concentration, 0.16 g/100 ml). A value of +104° has been reported for authentic barium D-glycerate (*9*).

As final evidence of the identity and configuration of the acid isolated from tobacco leaves, a sample was incubated with crystalline glyoxylic acid reductase (*3*) and DPN (oxidized diphosphopyridine nucleotide). This enzyme has specific D-glyceric acid dehydrogenase activity associated with it and catalyzes the following reaction:

$$\text{D-glycerate} + \text{DPN}^+ \rightleftarrows \text{hydroxypyruvate} + \text{DPNH} + \text{H}^+$$

A 6.67 m*M* solution of the sodium glycerate isolated from tobacco leaves was incubated with the enzyme and DPN. After the reaction had proceeded to equilibrium, the concentration of the added glycerate was calculated from the quantity of DPNH (reduced diphosphopyridine nucleotide) formed and was found to be 6.25 m*M* (*10*).

These data provide proof of the presence of D-glyceric acid in the tobacco leaf. The quantity present is of the order of 5 to 15 milliequivalents/kg (fresh weight) or 0.5 to 1.5 percent of the dry weight.

Leaf tissue that was plunged within a few seconds of being picked into boiling 70-percent alcohol or into boiling water also contained approximately the same quantity of glyceric acid. Thus, it seems unlikely that more than a small fraction of the free glyceric acid present in the dried leaf tissue arises from cleavage of 3-phospho-D-glyceric acid by phosphatases during the sampling procedure.

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References and Notes

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2. H. A. Stafford and A. Magaldi, *Plant Physiol.* 29, 504 (1954).
3. I. Zelitch, *J. Biol. Chem.* 216, 553 (1955).
4. F. A. Isherwood, Y. T. Chen, L. W. Mapson, *Biochem. J. London* 56, 15 (1954).
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6. Dowex 1 and Dowex 50 are anion- and cation-exchange resins, respectively, manufactured by Dow Chemical Co., Midland, Mich. The designation X8 or X10 refers to the percentage of cross-linkage in the resin.
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8. F. Feigl, *Spot Tests* (Elsevier, New York, 1954), vol. II, p. 251.
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10. I am indebted to I. Zelitch for this determination and to H. B. Vickery for helpful discussions throughout the course of this work.

1 September 1955

Small Polyribonucleotides with 5′-Phosphomonoester End-Groups

Study of the products of alkaline digestion of ribonucleic acid (RNA) from certain viruses has shown that in some cases the polynucleotide chain is terminated by a phosphate group esterified at carbon 5′ of the nucleoside moiety (*1*). This is also the case (*2*) with the highly polymerized polyribonucleotides synthesized by polynucleotide phosphorylase,

Table 1. Nucleotides derived from the AMP polymer. The R_f values and the electrophoretic mobilities show a regular progression with increasing length of chain. Further, the parent compounds and the products after treatment with phosphomonoesterase fall in the same order when listed according to extent of migration. This is supplementary evidence for a family of compounds belonging to a homologous series.

Ultraviolet absorbing band	Yield, expressed as micromoles of adenine*	R_f in isopropanol-NH_3†		Electrophoretic mobility‡	
		Before monoesterase§	After monoesterase	Before monoesterase	After monoesterase
I. Adenosine	0.1	0.43	0.43	3.9‖	3.9‖
II. Mononucleotide	0.4	0.14	0.43	9.0	3.9‖
III. Dinucleotide	0.25	0.07	0.23	12.0	3.0
IV. Trinucleotide	0.7	0.03	0.15	14.2	6.5
V. Tetranucleotide	0.6	0.01	0.05	14.2	7.8

* The incubation mixture contained 2.5 μmole (as adenine) of the AMP polymer. 0.5 μmole of ultraviolet absorbing material (expressed as adenine equivalents) appeared at the origin of the descending chromatogram, presumably long polynucleotides.
† See reference *10*.
‡ Paper electrophoresis in 0.05*M* formate, *p*H 3.5, was carried out exactly as described by Markham and Smith (*10*). Movement is expressed as centimeters per 2 hours, at 20 V/cm.
§ This was a purified seminal phosphomonoesterase (*4*), which removed the 5′-phosphomonoester group but did not split the 3′–5′ internucleotidic phosphodiester bond.
‖ This is extent of movement toward cathode. All other compounds migrated toward the anode.

an enzyme recently isolated from *Azotobacter vinelandii* (*3*). However, any small polynucleotides hitherto obtained by enzymatic or chemical degradation of RNA were shown to possess C3′ or C2′ phosphomonoester end-groups.

The only thoroughly studied enzyme known to liberate small polynucleotides from RNA is pancreatic ribonuclease. These oligoribonucleotides possess in all cases a terminal phosphate group esterified at C3′ (*4, 5*). The 5′-phosphate ended polyribonucleotides synthesized by polynucleotide phosphorylase (*6*) are no exception to this rule, since they yield 3′-phosphate ended oligonucleotides on digestion with pancreatic ribonuclease (*7*). Acid hydrolysis of RNA can also yield small polynucleotides but with the phosphomonoester end-group at C3′ or C2′, not at C5′ (*8*).

We have now found that small polynucleotides with C5′ phosphate end-groups are liberated on incubation of the biosynthetic adenosine-5′-phosphate (AMP) polymer (*6*) with an enzyme preparation from liver nuclei. Pancreatic ribonuclease has no action on the AMP polymer (*6*). A brief report of the isolation and identification of ribodinucleotides, trinucleotides, and tetranucleotides, consisting of adenosine-5′-phosphate residues linked to one another through 5′, 3′-phosphoribose diester bonds and therefore possessing C5′ phosphomonoester end-groups, is the object of this communication.

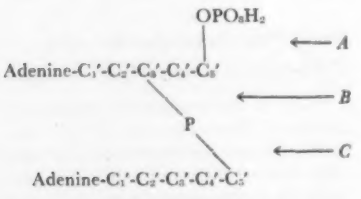

Fig. 1. 5′-Phosphoadenosine-3′ : adenosine-5′-phosphate. Arrows *A*, *B*, and *C* represent points at which dinucleotide can be hydrolyzed.

Extracts obtained from guinea pig liver nuclei, by treatment with alkali and potassium chloride as described by Mills *et al.* (*9*), were found to have nuclease activity toward the biosynthetic AMP polymer, producing small polynucleotides. This activity was partially purified by fractionation, first with neutral, then with alkaline ammonium sulfate.

The enzyme (0.26 mg protein) was incubated in 0.01*M* $MgCl_2$ and 0.02*M* phosphate buffer, *p*H 7.2, with 1.4 mg of the AMP polymer. After 20 hours at 37°C the incubation mixture (1.0 ml) was evaporated to 0.2 ml and directly chromatographed on Whatman No. 3MM paper in the isopropanol-ammonia system of Markham and Smith (*10*). Six bands were visible in ultraviolet light. Table 1 shows the amount of material in each band, expressed as adenine, as well as R_f values and electrophoretic mobilities.

Band I was found to be adenosine. Band II was shown to be adenosine-5′-phosphate, from its behavior on paper chromatography and paper electrophoresis, and by its conversion to adenosine with bull semen 5′-nucleotidase free of diesterase activity (*11*).

Band III was found to be the dinucleotide, 5′-phosphoadenosine-3′: adenosine-5′-phosphate, the structure of which is shown diagrammatically in Fig. 1. Identification of this dinucleotide is based on the following evidence. (i) It behaved chromatographically as an adenine containing dinucleotide. (ii) On treatment with purified human semen phosphomonoesterase (*4*) hydrolysis occurred at *A* (Fig. 1), and the compound was quantitatively converted to adenosine-3′: adenosine-5′-phosphate, a dinucleoside monophosphate. This derivative was identified by its R_f in two solvent systems and its electrophoretic mobility as compared with a previously studied reference compound derived from RNA (*12*). Furthermore, it yielded equimolar (1.0:1.1) amounts of adenosine and adenylic acid by treatment with either alkali (*10*) or spleen phosphodiesterase (*13*). (iii) The dinucleotide was quantitatively converted to adenosine-5′-phosphate by purified snake venom phosphodiesterase (*14*), by hydrolysis at *B* (Fig. 1). (iv) Hydrolysis for 18 hours at 24°C with 0.5*N* NaOH converted the dinucleotide to an equimolar (1.0:0.9) mixture of adenosine and adenosine 3′(2′):5′ diphosphate through splitting at *C* (Fig. 1). The diphosphates were identified by chromatographic and electrophoretic comparison (*12*) with adenosine 2′:5′ diphosphate derived from triphosphopyridine nucleotide (*15*). (v) Finally, oxidation with periodate followed by incubation at *p*H 10.5 (*16, 17*) led to cleavage at *C* (Fig. 1) giving, along with other oxidation products, adenine and adenosine-3′:5′ diphosphate. The latter was differentiated from adenosine 2′:5′ diphosphate, as is described elsewhere (*12*).

The compounds corresponding to bands IV and V were identified by similar methods as the corresponding trinucleotide and tetranucleotide, respectively. Both compounds were oxidized by periodate and were split to adenosine-5′-phosphate by snake venom phosphodiesterase, indicating the position of the phosphomonoester group at C5′. Small polyribonucleotides with 3′-phosphomonoester end-groups are not attacked by the venom preparation, but the venom does act on deoxyribopolynucleotides having 5′-phosphomonoester groups (*18*). Conversely, it is of interest that spleen phosphodiesterase, which rapidly hydrolyzes small polyribonucleotides with 3′-phosphomonoester end-groups, was unable to split the oligonucleotides of Table 1.

Recent work (*3, 6, 19*) has emphasized the significance of nucleoside-5′-polyphosphates in nucleic acid metabolism. Studies are under way to determine whether small polyribonucleotides with 5′-phosphomonoester end-groups may be intermediates in the synthesis as well as in the degradation of nucleic acids.

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14 December 1955

Effect of Cortisone on 17-Ketosteroid Excretion in Patients with Diabetes Mellitus

It has been fairly well established by several investigators (*1–6*) that the administration of cortisone to normal healthy adults as well as to patients with various nonmalignant diseases is associated with little if any rise in the excretion of urinary 17-ketosteroids. Hence our unexpected finding of a substantial rise in urinary 17-ketosteroids following the oral administration of cortisone to patients with diabetes mellitus was regarded with considerable interest, especially in view of the current interest in the possible role of the pituitary-adrenal axis in the development of vascular complications in diabetes mellitus (*7, 8*). The studies being reported were performed as part of a systematic exploration of the metabolic interrelationships between the adrenal cortex and diabetes mellitus (*9*). The effects of cortisone on the urinary excretion of 17-ketosteroids and also of reducing corticosteroids forms the basis of this preliminary report.

Each of six patients (four with unstable and two with stable diabetes, *10*), was studied on the metabolism ward for a prolonged period. Each patient received a chemically constant diet of identical foods and food values throughout the period of hospitalization. An initial stabilization period of at least 2 to 3 weeks, during which insulin type and dose were adjusted to achieve optimal regulation, was allowed before each cortisone experiment was begun. Patients received cortisone daily in equally divided doses around the clock (Table 1). Total urinary 17-ketosteroids were determined in duplicate by the modification of the method of Talbot *et al.* (*11*), including a correction for nonketonic chromogens. The reducing corticosteroids in urine were extracted with chloroform at *p*H 1.0 after hydrolysis for 48 hours with beta-glucuronidase at 47°C. The corticosteroids in the neutral extract were determined by a modification of a colorimetric method using blue tetrazolium (*12*).

The results are listed in Table 1. As a whole, the base-line excretion of 17-ketosteroids tended to be in the low-normal or slightly below-normal range. In the four patients who received both the low and moderately high doses of cortisone, a significant rise in the excretion of 17-ketosteroids was observed when small daily doses of cortisone were administered. An example is shown in Fig. 1. When the dose of cortisone was increased to 150 mg daily, a prompt sharp additional rise occurred in all four patients. The highest 24-hour increment above the average base-line value for these four patients was 40.1, 30.8, 34.3, and 23.9 mg, respectively. In the two patients who received the 150-mg doses only, the increments were less pronounced, being 7.1 and 9.1 mg, respectively.

In contrast to the control values for 17-ketosteroids, the control values (average) for total reducing corticosteroids were in the normal range. However, individual values both above and below the normal range were noted. The rise in reducing corticosteroids in response to

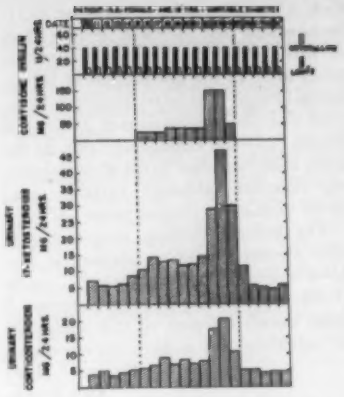

Fig. 1. An example of the marked response in the excretion of 17-ketosteroids and reducing corticosteroids to low and moderately high doses of cortisone.

low and moderately high doses of cortisone paralleled the rise in 17-ketosteroids, although in most cases it was not as great. When the cortisone was discontinued, both the urinary 17-ketosteroid and reducing-corticosteroid levels reverted promptly to the control values or below.

Marked rises in the urinary excretion of 17-ketosteroids following cortisone administration have also been reported in patients with prostatic carcinoma and other malignancies (*4, 13, 14*). These patients received larger doses of cortisone (300 mg daily) than those used in the present study. Although cortisone has induced sharp rises in the excretion of 17-ketosteroids in both diseases, it remains for future studies to determine whether or not the mechanisms are similar.

It is noteworthy that a diabetic may

Table 1. Excretion of 17-ketosteroids and reducing corticosteroids in response to oral administration of cortisone. The range of values of the amounts excreted is given in milligrams per 24 hours.

Patient	Control		Cortisone				Recovery	
			Dose of 25–37.5 mg/24 hr		Dose of 150 mg/24 hr			
	Days	Amount	Days	Amount	Days	Amount	Days	Amount
17-Ketosteroids								
N.B.	5	5.7– 8.7	7	10.3 –14.6	2	29.0–46.8	5	4.9– 5.8
S.S.	5	4.1– 7.5	6	4.9 –12.1	2	17.0–37.1	4	5.9–10.3
R.E.	5	1.7– 4.8	7	0.66– 9.3	2	10.8–37.1		4.89
J.P.	5	4.8– 8.7	7	8.7 –20.0	2	27.1–31.0	5	3.5– 8.3
G.W.	5	10.1–10.2			3	9.0–17.2	4	3.3–10.3
L.V.	5	2.3– 4.3			3	4.0–12.4	5	2.5– 5.3
Reducing corticosteroids								
N.B.	5	3.5– 5.1	7	5.7 – 8.9	2	17.6–20.5	5	4.2– 5.2
S.S.	5	2.3– 6.4	6	6.5 – 8.6	2	8.0–14.0	5	3.2– 7.9
R.E.	5	4.8– 5.8	7	6.5 – 9.5	2	10.6–21.7	4	4.3– 6.3
J.P.	5	6.9–15.5	7	3.7 –16.8	2	22.2–33.6	5	5.5–10.4
G.W.	5	5.5– 7.9			3	22.0–28.0	4	4.4– 5.5
L.V.	5	1.3– 7.7			3	6.2– 9.0	5	2.4– 5.9

show a transformation of cortisone to 17-ketosteroids that is much greater than normal, while the base-line excretion tends to be in the low-normal or below-normal range. The latter finding is in accord with the observations of Miller and Mason (*15*) and Lundbaeck (*16*). At the same time, base-line levels of corticosteroid excretion, although variable, tend to lie within the normal range (*17*).

The present findings suggest a possible altered steroid metabolism in diabetes mellitus. Their significance may be clarified by studies now in progress. A more detailed report of this study will be submitted for publication elsewhere.

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8 September 1955

Effect of Reserpine on Adrenocortical Function in Unanesthetized Dogs

Reserpine produces tranquility in agitated patients (*1*), and depressed hypothalamic function has been suggested as the mechanism of this action. Because the hypothalamus is involved in the regulation of ACTH secretion from the adenohypophysis (*2*), an assessment of adrenocortical function following reserpine administration is indicated. Gaunt and coworkers (*3*) have demonstrated adrenocortical hypertrophy in rats following reserpine administration—a finding suggesting stimulation of ACTH secretion rather than suppression. The present study (*4*) was undertaken to determine the effect of reserpine on adrenocortical function in dogs; we employed a direct and specific method for evaluating the secretory activity of the adrenal cortex.

In each of five male mongrel dogs, the right lumboadrenal vein was cannulated according to a technique described by Hume and Nelson (*5*). After a recovery period of 48 hours, samples of adrenal venous blood were collected from the resting, unanesthetized animals. Each dog was then given 5 mg of reserpine (Serpasil, Ciba) intravenously, and samples of adrenal venous blood were collected at intervals thereafter. All blood samples were analyzed for 17-hydroxycorticosteroid content (*6*). The animals became drowsy soon after the reserpine injection and remained so during the 3-hour period of blood sampling.

Table 1. Effect of intravenous reserpine on adrenal 17-hydroxycorticosteroid secretion in unanesthetized dogs. Output values for right adrenal gland only. When zero output is indicated, steroid concentration was below the sensitivity of the analytic method (0.1 to 0.2 μg).

Dog No.	Dose of reserpine		Minutes prior to injection			Adrenal 17-hydroxycorticosteroid output (μg/min) Minutes after injection								
	mg	mg/kg	10–20	5–10	0–5	0–5	5–10	10–20	20–30	30–45	45–60	60–90	90–120	120–180
1	5	0.12	1.3	0.4	0.5	1.0	0.0	0.0	1.3	17.5				
2	5	0.18		0.0	0.0	0.0	0.0	0.0	0.0	0.4	15.5			27.4
3	5	0.21	0.0		0.0	0.0	0.0	0.0	0.0	5.2	20.0	2.6	18.1	29.4
4	5	0.31	0.0	0.2	0.1	0.1		1.6	19.0	17.8	6.4	13.0		15.4
5	5	0.33	1.1	0.5	0.8	0.4	7.8	12.2	8.5		15.1	24.7	12.0	

The results are presented in Table 1. Following reserpine administration, a marked increase in adrenal corticoid secretion was observed in all cases. In four dogs, the response was delayed, with highest values occurring between ½ and 3 hours after drug injection. The maximal corticoid values following reserpine administration are similar in magnitude to those obtained following the intravenous injection of large doses of ACTH, though comparatively much delayed. While it may be assumed that the increase in adrenal steroid secretion following reserpine injection is mediated by ACTH secreted from the adenohypophysis, the mechanism underlying the delay in response remains obscure. This study indicates that reserpine, in the doses used, is a potent stimulus to adrenal cortical secretion in unanesthetized dogs. It should be emphasized that these results represent an acute response to a large dose of reserpine. They do not necessarily imply that any comparable adrenal response occurs to smaller oral doses used in clinical practice.

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9 September 1955

Note on Murphy's and Rhine's Comments

In recent issues of *Science* there have appeared comments by Murphy (*1*) and by Rhine (*2*), criticizing our report of "A methodological refinement in the study of 'ESP,' and negative findings" (*3*). We feel that these comments call for a brief rejoinder.

Both Murphy and Rhine seem inclined to dismiss our findings on the basis of the fact that our study "did not even pretend to replicate any previous research" (*2*) in the field of extrasensory perception. We can but point out that methodological improvement is generally considered a scientific desideratum and that the comparison of results obtained by one methodology with those obtained by another is a common scientific procedure.

Both critics object, also, to the nature of the targets employed in our study. In an effort to forestall such objections, we communicated in some detail with Rhine, as he has stated (*2*), before we actually undertook our experiment. We were particularly concerned with the question of the form of the targets and called it especially to Rhine's attention. Rhine's only misgivings on this point had to do with the issue of the "stacking error" (*2*; compare with Rhine, *4*), an issue that happens to have no relevance for our experimental design. Although he now makes an assertion to the contrary (*2*), Rhine did not at that time object to "the curious device of making

all the targets (or stimuli) to be identified by the subject *of one kind*" (*2*; italics in original) nor did he express any of the reservations indicated by Murphy (*1*). We are thus somewhat surprised to be confronted now by criticisms on this score. Although it is true that we employed targets of an unusual nature, it is also true that they were (i) virtually demanded by the experimental paradigm, and (ii) presented to the subjects with fair warning. We feel that they were entirely legitimate.

Rhine and Murphy offer further criticisms of our procedure; we feel, however, that these criticisms are adequately met in the original report, and we will not attempt to deal with them here. We cannot close, however, without pointing out that Murphy's own comments substantiate our distrust of "random numbers." His remarks also, unfortunately, perpetuate the fallacy that patterning in a target is of no consequence, provided that a large number of calls is made; and they call for support on the study of Schmeidler and Murphy (*5*), which is subject to many of the same qualifications (*6*) that apply to Schmeidler's later investigation (*7*).

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12 September 1955

Fluorescent Thorium Mineral

It has been generally accepted that thorium cannot be a major constituent of any mineral that fluoresces under ultraviolet radiation. In fact, this element is looked upon as a quencher of the fluorescence of uranium salts. Current literature generally recommends the sodium fluoride bead test as a means of distinguishing between radioactive uranium and thorium minerals, and it has been accepted that appreciable amounts of thorium in a mineral will quench any fluorescence of the bead that is produced by uranium. Minerals such as monazite that contain 1 percent uranium and 7 percent thorium will not yield fluorescent beads when the whole mineral grain is used. It has been found that these generally accepted premises are unreliable.

An unusual mineral from Montana has been brought to my attention (*1*). Under the short-wave ultraviolet light, this mineral fluoresces with a bright green color similar to that of uranophane. Under the microscope, it is evident that the fluorescence comes from the interior of the translucent grains and is distributed more or less uniformly. It is not caused by any surface coating.

In the hand specimen, the mineral is of a liver-brown color with a glassy to resinous luster; streak is a pale tan; hardness is about 5.5 (Moh); specific gravity is 4.534; fracture is splintery conchoidal; it is nonmagnetic and infusible before the blowpipe; it is slowly attacked by boiling concentrated sulfuric or hydrochloric acids, leaving a small white residue.

Microscopically, the mineral is transparent, uniaxial positive with moderate birefringence; the indices of refraction are 1.690 and 1.716.

A spectrographic analysis yielded the following results (*2*): thorium, high (10 to 100 percent); zirconium, medium (1 to 10 percent); silicon, low to medium; iron, low to medium; manganese, low (0.1 to 1 percent); and hafnium, low. There were traces of phosphorus, nickel, beryllium, germanium, and aluminum. The presence of a small amount (less than 1 percent) of uranium was noted. No traces of tantalum or niobium were found.

A radiological assay performed on a Ken Research Monitor indicated a thorium oxide content of 65 ± 2 percent. An independent chemical analysis (*2*) showed a thorium oxide content of 64.54 percent. Chemical analysis demonstrated a uranium oxide content of only 0.81 percent.

In view of the very high thorium content of this mineral and its very low relative uranium content, it is noteworthy that grains of the mineral give a strong positive reaction to the sodium fluoride bead test. If a small grain of the mineral is added to a molten bead of sodium fluoride, the bead emits a strong yellow-green fluorescence under both short- and long-wave ultraviolet. Although it is unusual that a mineral containing 65 percent thorium should yield a fluorescent bead, it is very peculiar that the addition of a minute amount of thorium from any other source immediately extinguishes the fluorescence. To make this unusual fact absolutely clear, I shall review the procedure.

A bit of chemically pure sodium fluoride is melted in a loop of platinum wire. The resultant bead is not fluorescent. A small grain of the mineral is then placed on the bead and the whole is reheated to fusion, whereupon the mineral dissolves completely with a slight effervescence. When it is allowed to cool, this bead fluoresces bright yellow-green under ultraviolet. If one then adds a small speck of monazite, thorite, or chemically pure thorium nitrate to this fluorescent bead and reheats to fusion, the resulting bead is not fluorescent. However, repeated additions of grains of the mineral to a fluorescent bead do not diminish the initial fluorescence.

X-ray diffraction patterns of the mineral are similar to those of thorite; although the optical and physical properties described here do not precisely correspond with those of the latter mineral, the specimen is tentatively ascribed to the thorite family.

Mineralogists and chemists should not consider that a highly radioactive mineral which fluoresces under ultraviolet is necessarily high in uranium content. Furthermore, the generally accepted sodium fluoride bead test cannot be relied on to distinguish between thorium and uranium minerals.

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Notes

1. The specimen was furnished by H. Wilson Cain, Thorium Metals Corporation, New York.
2. The analysis was performed by Ledoux and Company, Teaneck, N.J.

14 November 1955

I hope that my children, at least, if not I myself, will see the day when ignorance of the primary laws and facts of science will be looked upon as a defect only second to ignorance of the primary laws of religion and morality.—CHARLES KINGSLEY (1819–1875).

Book Reviews

Organic Insecticides. Their chemistry and mode of action. Robert L. Metcalf. Interscience, New York–London, 1955. x + 392 pp. Illus. $8.50.

The author, who is an entomologist at the University of California Citrus Experiment Station, Riverside, explains in the preface that the present work is an outgrowth of his monograph, *The Mode of Action of Organic Insecticides,* published in 1948 by the National Research Council. Although he is listed as an entomologist, R. L. Metcalf has made many important contributions in the fields of insecticide chemistry and toxicology.

The book is divided into 14 chapters, titled as follows: "Nicotine, nornicotine, and anabasine"; "Rotenoids"; "Pyrethroids"; "Joint action of insecticides"; "Organic thiocyanates"; "Dinitrophenols"; "Dichlorodiphenyltrichloroethane (DDT)"; "Acaricides"; "Benzene hexachloride"; "Cyclodiene insecticides"; "Organic phosphorus insecticides"; "Carbamates"; "Miscellaneous insecticides"; and "Insecticide resistance."

Each of the chapters on insecticides discusses the chemistry, mode of action on insects, relation of chemical structure to physiological activity, and the mammalian toxicity of a group of related organic materials. The chapter on "Joint action of insecticides" is restricted to pyrethrins and allethrin and materials that increase their activity. Synergists with DDT are covered in the chapter on resistance. The chapter on acaricides is limited to those materials effective against mites. "Ticks" are mentioned only casually in a few places in the text, and none of the common species are listed in the rather complete index.

Each chapter is documented with carefully selected references, a total of more than 1200 citations to the literature being given. Many references are to 1954 articles, and the patent literature is also adequately represented. The book is well organized and the selected subjects are thoroughly covered.

The most glaring omission seems to be the absence of information on the organic chemicals used as insecticidal fumigants (methyl bromide, ethylene dibromide, chloropicrin, and so forth) and insect repellents and attractants. A nonentomologist would have probably preferred the use of common names of insects instead of the scientific names that are given. Otherwise the book is written in a clear, concise, and easily readable style. As a result of his diversified experience, Metcalf was able to select for compilation into tables data that present in a small space much information from many sources.

In general, this is an excellent book that will be welcomed by all persons interested in insect physiology, toxicology, and insecticidal chemistry.

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Midwest and Its Children. The psychological ecology of an American town. Roger G. Barker and Herbert F. Wright. Row, Peterson, Evanston, Ill., 1954. vii + 532 pp. $7.50.

Midwest and Its Children is a report of a 7-year research project about the naturally occurring behavior of all the children in the American community labeled Midwest. Roger Barker and Herbert Wright raised a simple question: What kinds of behavior transactions take place between children and the places and people in their lives? Their answer is a monumental achievement consisting of a wealth of data, painstakingly gathered by rigorous and creative methods and organized and clarified by significant and meaningful concepts. Interspersed with the major report is a comparative study of disabled children from neighboring towns and from a school for crippled children. The latter added feature serves two purposes: to add to our understanding of the psychological problems of the physically disabled, and to test the value of the methods and concepts of psychological ecology that the authors have evolved.

A primary problem confronting the researcher in psychological ecology is the discovery and analysis of the relevant loci of behavior: the structure and dynamics of the community in which behavior occurs. The pertinent unit selected by Barker and Wright is the "behavior setting." Here again, a simple question led to complex, yet clarifying, answers. The section of the book devoted to this problem not only identifies the behavior settings of Midwest, along with explicit criteria for what constitutes a setting, but provides data about eight characteristics of settings. Thus, the reader not only is enlightened about their number, content, kinds, and varieties (community "size") but is also informed about the populations that enter the settings, the relative prominence of the settings in the lives of children, the kinds of action patterns and behavior mechanisms prevalent, the role that children play, and the degree to which they penetrate these settings. Not only are the living conditions of children thus mapped, categorized, and analyzed, but they are also plotted for the kind of *social weather* (approval, affection, acceptance, communication, and so forth) experienced therein. Further than this, the authors point up some of the implications of the behavior settings survey for the behavior, mental health, and development of Midwest's children.

A second section of the book has to do with the psychological habitats and behavior of children. The unit for this problem is the "behavior episode." To my mind, this is the most sophisticated and clearest discussion in the psychological literature of what constitutes the most appropriate and fruitful behavior unit for psychology. Conceptual definitions of behavior units, methods for observing, recording, and episoding behavior are clearly stated, together with ample concrete illustrations. Beyond the authors' contribution to the determination of behavior content and the definition of behavior units is their analysis of the "behavior stream" and their ability to delineate and define structural properties of this stream. Data are presented dealing with developmental changes in structural characteristics of behavior, the initiation and termination (spontaneous or pressured, and so forth) and the outcome (success or failure, and so forth) of episodes, and the comparison between Midwest children and the physically disabled children.

The third section of the book deals with social action and interaction. As with the other sections, concepts and categories are explicitly defined and adequately illustrated. Data are presented dealing with the frequency and complexity of interaction of the children with other categories of persons (other children, adults, fathers, mothers, and so forth), with the modes of interaction (dominance, nurturance, and so forth), with interplay variables (conflict, disjunction, and so forth), and so on. Comparative findings are also presented for the physically disabled as well as for

social interactions with the observers. The latter provide measurable evidence for the kind of role the observers actually succeeded in playing in the Midwest Field Station.

Since the book contains such a wealth of material, I can only point out what seems salient to me. Others may select different aspects as salient for them, such as parent-child relationships. This book possesses value for a variety of scientific disciplines. Its value for psychologists and sociologists should be obvious. Natural scientists might be curious to compare the concepts and methods of this sample of psychological ecology with those of their disciplines. Educators should find in it a gold mine of ideas for studying, evaluating, and comparing schools. Psychiatrists might profit from it, not only for what light it sheds on the constituents of a mentally healthful (or unhealthful) life for children, but also for its applications to the study of hospital milieus. Above all, it may be read for its intrinsic value—for its wealth of scientific concepts and methods and for its portrayal of the naturally occurring behavior of children in their real worlds.

JACOB S. KOUNIN
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Income of the American People. Herman P. Miller. Wiley, New York; Chapman & Hall, London, 1955. xvi + 206 pp. $5.50.

Historically, the U.S. Census Bureau has attempted to interpret its statistics either in separate monographs or as prefaces to the volumes of statistics. Perhaps the most brilliant of these interpretations is that of Walter F. Willcox, following the 1900 census. Following the 1950 census a series of such analyses was planned by the Census Bureau in conjunction with the Social Science Research Council and the Russell Sage Foundation. This study by Herman Miller, who is an employee of the Census Bureau, is one of the first to appear in this series.

"This is a book about people and income. . . . The primary aim . . . is to indicate the relation between the amount of income received by individuals and certain social and economic characteristics like geographic location, occupation, color, education, etc. The study also includes an analysis of the changes in income distribution which have taken place in the U.S. since the depression of the thirties, as well as an evaluation of the data which provide the basis for the findings" (p. ix). Some of the specific topics covered include: Analysis of the over-all income curve; role of geographic location and color; income differences attributable to occupation; age as a factor in income distribution; income and family status.

Most of the data analyzed are from the 1940 and 1950 censuses and from the annual reports on consumer income as obtained via the Census Bureau's monthly sample survey. The author has done an excellent technical job of handling these diverse statistics; for example, his analysis of the distribution of income, showing that the over-all skewed curve is the result of combining a number of component curves, each of which tends to be fairly symmetrical, is of the highest order of professional competency.

This technical proficiency, unfortunately, has not been combined with a very imaginative approach to the subject matter. The census monographs supposedly were to be broad in scope: ". . . broad exploration of new questions suggested by the new information, as well as narrowing the elements of doubt and controversy on old questions" (p. vi). Instead of such a comprehensive approach, the material has been presented in the traditional census manner. Not only have many highly relevant questions not even been asked, but of those that have been asked many have not been adequately answered, because advantage was not taken of the vast quantities of data available in the census files.

As an example of the kind of question not even asked, consider our current problem involving the shortage of certain classes of professional and skilled workers. To what extent, if any, does this shortage reflect the failure of our society to pay these people an amount commensurate with the importance we have ascribed to their occupations? As another example, after producing good evidence that income differentials probably narrowed since the depression of the 1930's, Miller devotes a chapter to "Factors related to recent changes in income distribution." Nowhere in this latter chapter, however, is the question even raised concerning what the influence of labor unions may have been. Even if no answer could have been provided, the question should have been raised as evidence of awareness of one of the important elements in our current life.

As an example of an inadequate answer, we should note the chapter on "Income and family status." Comprehensive cross-tabulations of the data collected by the 1950 census would have provided many answers about the "working wife" that could not be obtained by merely looking at the marginal distributions obtained from the small annual sample surveys of income (which, incidentally, have high sampling variability). The student who is not an employee of the Census Bureau can raise questions, but he does not have easy access to the vast quantities of unused data that are available in the files of the Census Bureau; he is dependent, then, on the Census Bureau for either the basic statistics or the analyses.

A. J. JAFFE
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American Men of Science. A biographical directory. vol. II, *Biological Sciences.* Jaques Cattell, Ed. Science Press, Lancaster, Pa., and Bowker, New York, 1955. 1276 pp. $20.

The appearance of the second volume of the ninth edition of the biographical directory, *American Men of Science—Biological Sciences,* on schedule, will please all who have occasion to verify the names, current addresses, or research specialties of United States and Canadian scientists working or teaching in such areas as "zoology, botany, medical research and affiliated fields." The format is similar to that of volume I, *Physical Sciences,* which was published in the spring of this year, but it is not identical. About 25,000 biographies are included, and there are some 5000 additional references, principally to biochemists and biophysicists who elected to be listed in volume I. There are also a few instances when the reader is referred to the eighth edition of 1949. These sketches, added to the nearly 44,000 in volume I, total 69,000, and it is estimated that when the third volume on the social sciences appears early in 1956, no fewer than 95,000 individuals will be listed in the directory—almost twice the number in the previous one-volume edition. Apparently the same abbreviations and sequence of data on each sketch are consistently employed, and the editor, Jaques Cattell, is the same as for the eighth edition. If the standards for inclusion in this ninth edition are also unchanged, it follows that the number of scientists in North America has virtually doubled within the past 6 or 7 years.

As before, with the exception of four pages devoted to procrastinators, the biographical sketches are in one alphabetical sequence (except that, unlike the telephone directories, the "Macs and Mc's" are commingled and all precede Macy and Mad-), two columns per page, in typescript, reduced and printed by offset. In contrast with the eighth edition, a good grade of white paper is used and the attractive dark blue cloth binding with a scarlet and gold panel on the spine seems to be much stronger. The physical weight is not inconsiderable; most secretaries will need to use both hands in using these volumes. Those looking up a scientist among the 5000 whose biographies appear in volume I may be annoyed, especially if that volume, which also costs

$20, has not been purchased. With a slightly greater reduction in type size, three columns per page, and thinner paper, a combined single volume might have been feasible; or, if not, three somewhat thinner volumes encompassing all names would have been more desirable than the present division by disciplines. This basic fault, however, should not detract from the unquestionable value that this standard directory of American science has and the editor and all concerned are to be congratulated on their thoroughness, high degree of accuracy, and adherence to their printing schedule.—R.L.T.

Transistors and Other Crystal Valves. T. R. Scott. MacDonald & Evans, London; Essential Books, Fairlawn, N.J., 1955. xvi + 258 pp. $7.20.

Scott's book offers an organized review of nearly 300 papers that are related to transistors. Although it contains little that is new, it provides a readable introduction to the subject, including considerable historical background.

The author's style is quite informal, and it is clear that he is writing for an engineering, rather than a scientific, audience. Considerable attention is devoted to a comparison of various commercial rectifier and transistor types and to discussions of their construction and operating characteristics. Almost every statement is documented by a reference to the large bibliography. The text includes a generous assortment of formulas and curves that describe the semiconductor phenomena under discussion.

The opening chapters describe the evolution of semiconductor work and review the principles of rectifier and transistor operation. A chapter is devoted to methods of making p-n junctions and the manner in which they function. Operating characteristics of various kinds of junction devices are presented and discussed. The text then gives a discussion of point-contact devices, followed by short sections on performance and circuitry. The chapter on the design and construction of high-frequency transistors includes discussions of unipolar devices and negative resistance diode amplifiers. After a review of compound semiconductors and a look into the future, the book concludes with one appendix on the band theory of semiconductors and another on testing techniques.

In a survey work of this kind, it was surprising to find that several important contributions were unmentioned; Kroemer's drift transistor and the photoelectromagnetic effect are examples. Moreover, there is a fairly liberal assortment of minor errors. Since this book gives only superficial treatment to transistor technology, it probably will be of limited value to most specialists in the field. On the other hand, it will be welcomed by newcomers who wish an opportunity to become acquainted with transistors without being required to struggle through the mathematical detail that is found in more advanced textbooks.

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General Physics Department,
General Electric Research Laboratory

New Books

Fundamentals of Qualitative Chemical Analysis. Semimicro method. Roy K. McAlpine and Byron A. Soule. Van Nostrand, Princeton, N.J., ed. 4, 1956.

Elements of Quantitative Analysis. Theory and practice. Hobart H. Willard, N. Howell Furman, and Clark E. Bricker. Van Nostrand, Princeton, N.J., ed. 4, 1956. 576 pp. $5.85.

A Paris Surgeon's Story. Charles F. Bove with Dana Lee Thomas. Little, Brown, Boston, 1956. 306 pp. $4.50.

The Microbe's Contribution to Biology. A. J. Kluyver and C. B. Van Niel. Harvard University Press, Cambridge, Mass., 1956. 182 pp. $4.

The Marine and Fresh-Water Plankton. Charles C. Davis. Michigan State University Press, East Lansing, 1955. 562 pp. $10.

Temperatur und Leben. H. Precht, J. Christophersen, and H. Hensel. Springer, Berlin, Germany, 1955. 514 pp. DM 78.

Précis de Gérontologie. Léon Binet and Francois Bourlière. Masson, Paris, 1955. 554 pp. Paper, F. 3800; cloth, F. 4500.

Sites of Infection. Unstable areas as sources of parasitic diseases: schistosomiasis and fascioliasis. Alan Mozley. Lewis, London, 1955. 86 pp. 9s.

Fluidization. Donald F. Othmer. Reinhold, New York; Chapman & Hall, London, 1956. 231 pp. $7.

Comparative Endocrinology of Vertebrates. pt. I, *Comparative Physiology of Reproduction and the Effects of Sex Hormones in Vertebrates.* Memoirs of the Society for Endocrinology No. 4. I. Chester Jones and P. Eckstein, Eds. Cambridge University Press, New York, 1955. 253 pp. $8.50.

Mysterious Waters to Guard. Essays and addresses on anaesthesia. Wesley Bourne. Thomas, Springfield, Ill., 1955. 398 pp.

Immunology and Serology. Philip L. Carpenter. Saunders, Philadelphia–London, 1956. 351 pp.

The Nature of Hypnosis. Paul Schilder. Trans. by Gerda Corvin. International Universities Press, New York, 1956. 204 pp. $4.

Preventive Medicine in World War II. vol. III, *Personal Health Measures and Immunization.* Ebbe Curtis Hoff, Ed. Office of the Surgeon General, Department of the Army, Washington, 1955 (Order from Supt. of Documents, GPO, Washington 25). 394 pp. $3.25.

Applications of Spinor Invariants in Atomic Physics. H. C. Brinkman. North-Holland, Amsterdam; Interscience, New York, 1956. 72 pp. $3.25.

Modern Surveying for Civil Engineers. The practice of surveying, estimating and setting out works of all kinds, including chapters on modern photographic and aerial surveying as applied to engineering enterprises. Harold Frank Birchal. Philosophical Library, New York, rev. ed. 2, 1956. 524 pp. $15.

Thinking about Thinking. Merl Ruskin Wolfard. Philosophical Library, New York, 1955. 273 pp. $5.

An Index of Mineral Species and Varieties Arranged Chemically. With an alphabetical index of accepted mineral names and synonyms. Max H. Hey. British Museum (Natural History), London, ed. 2, 1955. 728 pp. £3.

Races and People. William C. Boyd and Isaac Asimov. Abelard-Schuman, New York, 1955. 189 pp. $2.75.

Der Bodenfrost Als Morphologischer Faktor. Josef Schmid. Hüthig, Heidelberg, Germany, 1955. 144 pp.

Neurologic Examination of the Dog. With clinicopathologic observations. John T. McGrath. Lea & Febiger, Philadelphia, 1956. 181 pp. $5.

Advances in Electronics and Electron Physics. vol. VII. L. Marton, Ed. Academic Press, New York, 1955. 527 pp. $11.50.

Information Theory in Psychology. Problems and methods (Proceedings of a conference on the estimation of information flow, Monticello, Ill., 5–9 July 1954, and related papers). Henry Quastler, Ed. Free Press, Glencoe, Ill., 1955. 436 pp. $6.

The Science Book of Space Travel. Harold Leland Goodwin. Pocket Books, New York, 1955. 213 pp. $0.35.

Blood Group Substances. Their chemistry and immunochemistry. Elvin A. Kabat. Academic Press, New York, 1956. 330 pp. $8.

Geriatria Gerontologia Vejez. José Froimovich S. The Author, Laboratorio Medicina Experimental, Valparaiso, Chile, 1955. 356 pp.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Modifications of Pattern in the Aortic Arch System of Birds and Their Phylogenetic Significance. Proceedings of the U.S. National Museum, vol. 104. Fred H. Glenny. 1955. 97 pp. *Three Miocene Porpoises from the Calvert Cliffs, Maryland.* vol. 105. Remington Kellogg. 1955. 54 pp. *Smithsonian Institution, Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents for the Year ended 30 June 1955.* Publ. 4230. 1956. 173 pp. *Synonymical Notes on Neotropical Flies of the Family Tabanidae (Diptera).* Misc. Coll. vol. 131, No. 3. G. B. Fairchild. 1956. 38 pp. Smithsonian Institution, Washington 25.

Canada, National Research Council Review, 1955. N.R.C. 3678. National Research Council, Ottawa, Canada, 1955. 268 pp. $0.75.

Johns Hopkins University, Annual Report of the President, the Faculties, and the Administration, 1954. Johns Hopkins University, Baltimore, Md., 1955. 184 pp.

Scientific Meetings

Abstracting Board of International Council of Scientific Unions

On 20 June 1949, an international conference met in Paris, at the seat of UNESCO; it had been organized by the Department of Natural Sciences of UNESCO (P. Auger, director) and was convened to deal with problems connected with scientific abstracting. Most of these problems were dealt with and were mentioned in the recommendations listed in the final act. One emphasized the importance of establishing good cooperation between existing scientific abstracting services and proposed the creation of coordinating committees; another urged that all original articles appearing in scientific journals should begin or end with an author's abstract (synopsis) prepared according to a set of rules published by the Royal Society; and another recommended the publication of a single international general abstracting journal for physics and cognate sciences (astrophysics, engineering, geophysics).

This proposal for the establishment of a single international journal of physics abstracting, preferably bilingual (English and French being used in a single edition), originated in the fact that at the time, international cooperation seemed to have in physics abstracting a simpler and more promising starting point than anywhere else in the vast field of scientific documentation: only two journals existed to cover the whole field of physical sciences and shared between them the international clientele of professional physicists; the possibility of an agreement between them to merge into a single international publication had been enthusiastically considered by the subcommittee that drafted the recommendation; the possible disadvantage of bilingualism seemed an inexpensive and acceptable mutual concession, a step on the main road to international good will. The objections of a few experienced delegates had little influence on the final wording of the recommendation, which was passed and published in the final act in the atmosphere of agreement that always surrounds the voting of counsels of perfection.

On 26 June 1949, the follow-up of the three afore-mentioned recommendations was discussed at a meeting organized by the International Union of Physics, and it was suggested that a joint commission be formed by ICSU to discuss this problem. This was done and the joint commission met for the first time in Paris on 20 Dec. 1949. It was soon decided that the editors of the principal reviews publishing original articles in physics throughout the world should be asked to state whether their journals agreed to publish synopses of all original articles, in English or in French, and whether the editor would accept the responsibility of examining the synopses to make sure that they were drafted in accordance with the Royal Society's rules. But a fact of fundamental nature had been overlooked: no abstracting journal of any kind was represented as such on the joint commission. Unanimous in its appreciation of the fine work done by both *Science Abstracts* and the *Bulletin Analytique*, the joint commission felt that the necessary improvements and enlargements could be discussed only in the presence of persons representing the interests and the spirit of these journals. A meeting of editors and users of abstracts was thus organized in London in September 1950.

During this meeting a vital change took place in the spirit in which the whole problem had been considered before: at the opening of the discussions, this had been theoretical and didactic; when the meeting closed, it had become constructive and realistic, and it was concluded that the publication of such a bilingual journal of abstracts as recommended by UNESCO was to be conceived perhaps as an ultimate goal that could not be reached within a measurable time. Cooperation must therefore proceed along other lines. At the close of the proceedings the main ideas that were to govern the future attitude of all persons concerned were as follows: All leading periodicals publishing original papers in physics should undertake to publish authors' summaries prepared according to rules set forth by the Royal Society and UNESCO; these summaries should be printed in English or French; an exchange of proofs or clippings of the synopses should be established; the editors should cooperate and remain in close contact to speed up and increase the efficiency of their work, and a responsible permanent international organization should be able to help them.

Let us pause to consider what progress had been made and in which direction. To be short and schematic, the spirit of the whole undertaking had been changed. In 1949, a gathering of physicists explained to editors of abstracting journals how they should do their work; a year after almost the same persons addressing the same editors were asking "What can we do to help you?" In 1949, it was thought that a single international abstracting journal should be founded in the near future, and it was hoped that the existing reviews would be content to merge into this new undertaking. In 1950, it was recommended that two independent journals be helped in their work by an international organization. It was realized that physics abstracting was an important asset in the scientific world and that it could and should be improved.

At the next meeting of the joint commission, it was decided to dissolve it and to constitute a Board for the International Abstracting Service. This was done, and the board, maintained by funds originating from UNESCO and ICSU and controlled by ICSU, was constituted and began operation on 1 June 1952. It obtained legal personality in Belgium by an Arrete Royal dated 3 Nov. 1953. On 1 Nov. 1953, *Physikalische Berichte* was admitted as the third member-journal for the German language.

What has the ICSU Abstracting Board done for physics and for its member-journals?

Authors' summaries. With the exception of a very few publications, all periodicals carrying original articles on physics and published in the U.S.A., U.K., Canada, Australia, Netherlands, Belgium, France, and Italy have agreed to publish authors' summaries written according to the rules approved by the Royal Society and UNESCO. The editor responsible has agreed to see to it that the summaries prepared sum up correctly and clearly the substance of the papers. In many instances, this supervision has been so thorough that the member-journals print these summaries *verbatim*, thereby saving the delay of abstract revision. All summaries printed in the countries listed here are printed either in French or in English (or both). The same result continues to obtain in Scandinavia and Germany and has recently been extended to Japan.

Proofs, clippings, microfilms. Fifty-five journals printed in the U.K., U.S.A., Netherlands, France, Germany, Italy, Sweden, Japan, and the U.S.S.R. send to the board or its associates, generally by air mail, either complete page proofs

or (in a few cases) clippings of authors' summaries. When these documents are received in only one copy, this is microfilmed or photocopied in order that all member-journals may be served.

Russian literature in physics. In 1954, the ICSU Abstracting Board got in contact with the director of the Institute of Documentation of the U.S.S.R. Academy of Sciences, D. Panov. It was agreed to exchange proofs of the six most important Russian journals of physics and the eight second in importance. This exchange started in February 1955. The proofs arrive in Paris where the Russian literature is microfilmed and sent on in this form to the editors of the member-journals.

Upon the request of the American Institute of Physics, which contemplated publishing the literal translation of one or more of the important journals of physics, the board instituted an inquiry in 12 European countries to assess the feasibility of this scheme. The results were communicated to the American Institute of Physics, which announced the publication, beginning 1 Nov. 1955, of a full English translation of the Russian *Journal of Theoretical and Experimental Physics.*

Acting jointly with the Publications Committee of IUPAC, the Board also helped to organize the work of publishing review articles describing the activities and progress of the principal schools of research in physics of the U.S.S.R. and other Slavonic-speaking countries. Two supplementary numbers of *Il Nuovo Cimento* have already appeared.

Classification. The UDC classification in physics is now undergoing revision. This move, urged by this board since 1952, has originated in the Federation Internationale de Documentation. The board and the Publications Commission of IUPAP have joined forces to cooperate on this revision, and both are represented on the FID special committee by the editor of one of the member-journals. The new classification will be used uniformly by all member-journals of the board.

Nonperiodical publications. To facilitate abstracting work in this field, the editor of each member-journal is now dealing with nonperiodical publications of a group of countries and directs the attention of his fellow-editors to those publications that he coniders of interest to physicists.

The board asked IUPAP to impress upon organizers of congresses and colloquia the importance of providing proper means of publication of the proceedings of these meetings, preferably in recognized journals and, if they issue special reports, to send these publications to the board to insure thorough and competent abstracting.

Chemistry. ICSU authorized the extension of the board's activities to chemistry in October 1954, and IUPAC recommended the candidatures of *Chemical Abstracts* and the *Bulletin Analytique* as member-journals for chemical abstracting in English and in French, respectively. These journals were unanimously elected to the board. The Zurich and Heidelberg meetings defined the ways and means of the new undertaking. Work has begun, and the editors of a select number of important chemical journals are already being communicated with, with a view to organizing page-proofs exchange between members for chemistry.

UNESCO, from the first days, has continually supported the new service. The growth of the ICSU Abstracting Board has been slow, chiefly because of the necessary prudence that has always governed its action. Also, this venture in international cooperation involved a great deal of work that had to be done with limited means, and it was a new undertaking. The members of the board had to demonstrate to all parties concerned the possibility and utility of the enterprise. From the fact that, in the wake of IUPAC, the International Union of Mechanics and the International Union of Biology have expressed interest in the board's work, it may be deduced that this demonstration is now complete. The problem still remains of how to deal successfully with the large increase of work arising from the new activity in chemistry. Also, other means of support, perhaps, should be provided. From many quarters, satisfaction has been expressed about the work done and the results obtained. Has it been realized everywhere that these involved much time and effort, freely granted by men whose reward was the promotion of international good will?

G. A. Boutry, *Secretary*
International Council of Scientific Unions, Paris, France

Meeting Notes

■ On 25 Jan. the first meeting of a new medical society, the Western Association of Physicians, was held under the presidency of Robert H. Williams, professor of medicine at the University of Washington. The objectives of the society are to provide meetings for persons with an established, active role in clinical research. Experimentation will be conducted with different types of scientific reports. Participants will present not only their recent investigations but also summaries of progress in their respective fields.

The scientific programs for the Western Association of Physicians, for the Western Society for Clinical Research, and for the Western Section of the American Federation for Clinical Research are to be integrated. The officers of the association for 1956–57 are Maxwell M. Wintrobe, professor of medicine, University of Utah; v. pres., T. L. Althausen, professor of medicine, University of California; sec.-treas., Joseph F. Ross, associate dean and professor of medicine and radiobiology, University of California College of Medicine at Los Angeles.

■ The department of plant sciences of Syracuse University will hold a conference on extraneous matter in foods on 16 Apr. The speakers and their topics will be as follows: J. E. Despaul, "Penetration of protective coverings by insects"; R. Fogler, "The sap beetle—its habits and possible control measures in sweet corn"; K. L. Harris, "Role of microscopic analysis in food and drug control"; F. B. Thatcher, "Recovery of insect fragments from flour: a modification useful for survey purposes, and some correlation with other factors"; and R. Cory, "Use of semipermanent mounts in sanitation collaborative work" (to be read by J. Monier).

The meeting has been arranged for food sanitarians, laboratory microanalysts, and others engaged in the protection of foods. Those planning to attend should notify Dr. J. D. Wildman, Department of Plant Sciences, 209 Lyman Hall, Syracuse University, Syracuse 10, N.Y.

■ Thirty-two science teachers from schools in seven western states will receive $200 fellowships for the 1956 West Coast Science Teachers Summer Conference, which will be held 17–30 June at Oregon State College. The conference will be cosponsored by the Future Scientists of America Foundation of the National Science Teachers Association, Oregon State College, and the Crown Zellerbach Foundation, San Francisco, Calif.

Teachers of any science course in grades 7 through 12 in the schools of Washington, Oregon, California, Idaho, Utah, Nevada, and Arizona are eligible to apply for a fellowship. Application forms may be obtained from the Future Scientists of America Foundation, National Science Teachers Association, 1201 16 St. NW, Washington 6, D.C.

■ A Symposium on X-ray Microscopy and Microradiography will take place at the Cavendish Laboratory, Cambridge, England, 16–21 Aug. The symposium, which is sponsored by the International Union of Pure and Applied Physics, will consider all microscopic methods that employ x-rays. The meeting is intended to be a gathering of those with some direct experience or interest, rather than a large public conference. Primary em-

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If several re-readings of that last paragraph leave it still tightly locked, get the Kodak Data Book "Color As Seen and Photographed," which is part of the Kodak Color Handbook, *on sale by your Kodak dealer. It explains better, with diagrams. If all you want are nice color photographs, he can load you up right then and there with all the* Kodacolor *and* Kodachrome Film *you want to pay for.*

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phasis will be placed on the physical methods, in theory and practice.

Sessions are planned on the reflection method, the contact method, and the projection method, and leading exponents will introduce each subject. Sessions will also be devoted to applications in biology, medicine, metallurgy, and other fields, including industrial applications. The Academic Press will publish the proceedings.

Because hotel rooms are difficult to get in August, those requiring such accommodation should supply the exact dates of their stay as soon as possible. For information, communicate with Dr. W. C. Nixon, Cavendish Laboratory, Cambridge, England.

■ The International Congress of Clinical Chemistry will be held 9–14 Sept. at the Hotel New Yorker, New York. The program of the congress will have as its principal topic "The significance of metabolic systems in clinical chemistry." Morning sessions will be devoted to reviews of selected subjects by invited speakers, chiefly from overseas, and afternoon sessions to contributed papers. Abstracts of the latter should be sent to the chairman of the scientific program, Dr. Harry Sobotka, Mount Sinai Hospital, New York 29, N.Y., *before 15 May*.

Exhibits of scientific interest are to be an important feature. Arrangements should be made with the chairman of the Scientific Exhibits Committee, Dr. Charles L. Fox, New York Medical College, Fifth Ave. and 105 St., New York 29, also *before 15 May*. For general information, address the secretary, John G. Reinhold, 711 Maloney Bldg., University of Pennsylvania, Philadelphia 4, Pa.

■ A comprehensive review of accomplishments in the electronic components field and a survey of future trends will highlight the 1956 Electronic Components Symposium that is to be held in the Department of Interior Auditorium, Washington, D.C., 1–3 May. The theme of the meeting is "Components—accomplishments and trends." Engineers and scientists from both industry and Government will deliver technical papers covering present and future developments of a variety of electronic components.

Arrangements for the 1956 symposium are under the direction of A. W. Rogers, U.S. Army Signal Corps, Fort Monmouth, N.J. The technical program is being developed under the supervision of P. S. Darnell, Bell Telephone Laboratories, Inc., Whippany, N.J. Sponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers, the Radio-Electronics-Television Manufacturers Association, and the West Coast Electronic Manufacturers Association, with the active participation of the Department of Defense and the National Bureau of Standards, the program will be divided into seven sessions, including an evening session devoted to electron tubes and solid-state devices.

The opening session on 1 May will include addresses by well-known representatives of industry and Government from this country, England, and Canada Approximately six speakers will be heard during each of the ensuing six sessions.

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Society Elections

■ American Society of Zoologists: pres. Tracy Sonneborn, Indiana University; v. pres. John Buck, National Institutes of Health; sec., Rudolph T. Kempton, Vassar College; treas., Theodore L. Jahn.

■ Alaskan Science Conference: pres., Troy L. Péwé; v. pres., Charles W. Wilson; treas., Arthur S. Buswell; sec., Howard C. Baltzo; National Councilor, Earl H. Beistline.

■ Society for the Study of Evolution: pres., Jens C. Clausen, Carnegie Institution of Washington, Stanford, Calif.; sec., Harlan Lewis, Department of Botany, University of California; treas., W. Frank Blair; the vice presidents are Charles M. Bogert, Carl Epling, Michael J. D. White. AAAS representative, Bruce Wallace, Long Island Biological Laboratory, Cold Spring Harbor, N.Y.

■ Association for Research in Nervous and Mental Disease: pres., Harry C. Solomon; 1st v. pres., Stanley Cobb; 2nd v. pres., Wilder Penfield; sec.-treas., Rollo J. Masselink, 710 W. 168 St., New York 32; asst. sec., Lawrence C. Kolb.

Forthcoming Events

April

8–10. American Assoc. of Colleges of Pharmacy, Detroit, Mich. (R. A. Deno, Colleges of Pharmacy, Univ. of Michigan, Ann Arbor.)

8–12. Scientific Apparatus Makers Assoc., 38th annual, Belleair, Fla. (SAMA, 20 North Wacker Dr., Chicago 6, Ill.)

8–13. American Chemical Soc., Dallas, Tex. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6.)

8–13. American Pharmaceutical Assoc., annual, Detroit, Mich. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7.)

8–13. Symposium on Problems of Automation, Milan, Italy. (Consiglio Nazionale delle Ricerche, Ufficio Congressi e Mostre, 7 Piazzale delle Scienze, Rome, Italy.)

9–11. American Assoc. of Feed Microscopists, annual, Terre Haute, Ind. (R.

C. Wornick, Agricultural Research Dept., Chas. Pfizer & Co., Inc., Terre Haute.)

9–12. International Anesthesia Research Soc., 30th annual cong., Miami Beach, Fla. (R. J. Whiteacre, 13951 Terrace Rd., Cleveland 12, Ohio.)

10–11. Symposium for Management on Applications of Analog Computers, Kansas City, Mo. (O. Fanning, Midwest Research Inst., 425 Volker Blvd., Kansas City 10.)

10–12. Council for Agricultural and Chemurgic Research. 21st annual, Chicago, Ill. (J. W. Ticknor, CACR, 350 Fifth Ave., New York 1.)

12. Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawes Products, 4800 S. Richmond, Chicago 32.)

13–14. Louisiana Acad. of Science, annual, New Orleans, La. (H. B. Boudreaux, Dept. of Zoology, Louisiana State Univ., Baton Rouge 3.)

14. South Carolina Acad. of Science, annual, Clemson, S.C. (H. W. Freeman, Univ. of South Carolina, Columbia.)

15–16. American Soc. for Artificial Internal Organs, Atlantic City, N.J. (P. F. Salisbury, Cedars of Lebanon Hospital, 4751 Fountain Ave., Los Angeles 29, Calif.)

15–20. American Soc. for Pharmacology and Experimental Therapeutics, Atlantic City, N.J. (C. C. Pfeiffer, Emory Univ. School of Medicine, Emory University, Ga.)

15–21. American Inst. of Nutrition, Atlantic City, N.J. (R. W. Engel, Virginia Polytechnic Inst., Blacksburg.)

15–21. American Physiological Soc., Atlantic City, N.J. (M. O. Lee, 9650 Wisconsin Ave., NW, Washington 14.)

15–21. American Soc. for Experimental Pathology, annual, Atlantic City, N.J. (C. C. Erickson, 858 Madison Ave., Memphis, Tenn.)

16–18. Aero Medical Assoc., 27th annual, Chicago, Ill. (J. P. Marbarger, Aeromedical and Physical Environment Lab., Univ. of Illinois, Chicago.)

16–19. Conf. on Communication of Information by Workers Studying Sounds of Biological Significance, University Park, Pa. (H. Frings, Dept. of Zoology and Entomology, Pennsylvania State Univ., University Park.)

16–20. American Assoc. of Immunologists, Atlantic City, N.J. (F. S. Cheever, Graduate School of Public Health, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

16–20. American College of Physicians, 37th annual, Los Angeles, Calif. (E. R. Loveland, ACP, 4200 Pine St., Philadelphia 4, Pa.)

16–20. American Soc. of Biological Chemists, Atlantic City, N.J. (P. Handler, Dept. of Biochemistry, Duke Univ., Durham, N.C.)

16–20. Federation of American Societies for Experimental Biology, 40th annual, Atlantic City, N.J. (M. O. Lee, 9650 Wisconsin Ave., NW, Washington 14.)

17–19. Atomic Energy and Its Implications for Southern Industry, Atlanta, Ga. and Oak Ridge, Tenn. (O. H. Townsend, Atomic Industrial Forum, Inc., 260 Madison Ave., New York, N.Y.)

18–19. National Industrial Research Conf., Chicago, Ill. (J. J. Kowal, Armour Research Foundation, Illinois Institute of Technology, 10 West 35 St., Chicago 16.)

18–20. American College of Allergists, 12th annual, New York, N.Y. (F. W. Wittich, 401 La Salle Bldg., Minneapolis 2, Minn.)

18–20. Conf. on Marine Corrosion and Fouling Problems, La Jolla, Calif. (Univ. of California Engineering Extension, Los Angeles 24.)

19–21. Assoc. of Southeastern Biologists, Durham, N.C. (J. C. Dickinson, Univ. of Florida, Gainesville.)

19–21. Ohio Acad. of Science, 65th annual, Springfield. (R. W. Dexter, Kent State Univ., Kent, Ohio.)

20–21. Arkansas Acad. of Science, annual, Arkadelphia. (L. F. Bailey, Dept. of Botany and Bacteriology, Univ. of Arkansas, Fayetteville.)

20–21. Bioengineering Symposium, 2nd, Terre Haute, Ind. (W. L. Keko, Commercial Solvents Corp., Terre Haute.)

20–21. Biometric Soc., jointly with Inst. of Mathematical Statistics, Princeton, N.J. (A. M. Dutton, Univ. of Rochester, Box 287, Station 3, Rochester 20, N.Y.)

(See issue of 17 February for comprehensive list)

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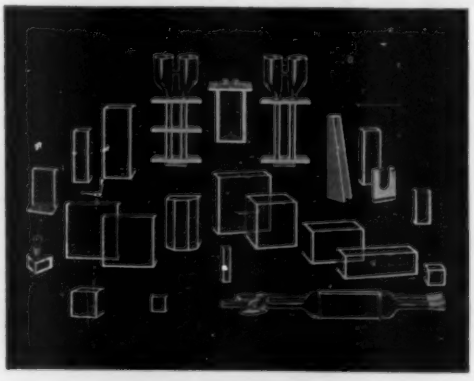

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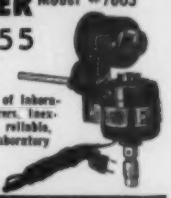

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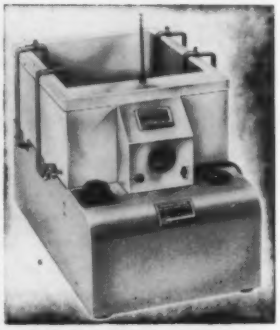

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Sex in Microorganisms

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The genetic, physiological, and morphological evidence for "sex" in the principal groups of microorganisms—viruses, bacteria, fungi, unicellular algae, and protozoa—is presented by a group of experts in the field.

N. Visconti of the Carnegie Institution of Washington at Cold Spring Harbor, discusses recombination of "genes" in viruses. J. Lederberg of Wisconsin and E. L. Tatum of Stanford review genetic evidence for "sex" in bacteria, and W. G. Hutchinson of Pennsylvania and H. Stempen of Jefferson Medical College describe cell fusions in certain bacteria. J. R. Raper offers a comprehensive coverage of sex in fungi.

R. Patrick of the Academy of Natural Sciences, Philadelphia, describes syngamy in diatoms; R. A. Lewin of the Maritime Regional Laboratory, Halifax, the sexuality of other unicellular algae, especially the flagellates.

In two chapters D. H. Wenrich covers sexual phenomena in some of the protozoa and discusses the origin and evolution of sex, based primarily on the protozoa, but including material about all of the microorganisms. D. L. Nanney of Michigan summarizes mating-type phenomena in *Paramecium aurelia* and some of the recent mating-type work from Sonneborn's laboratory. C. B. Metz of Florida State compares mating-type substances in *Paramecium* and other ciliates with those found in Metazoa. Extensive chapter bibliographies are included.

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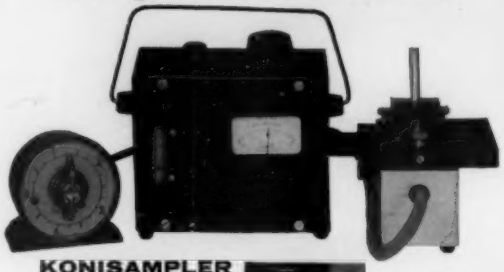

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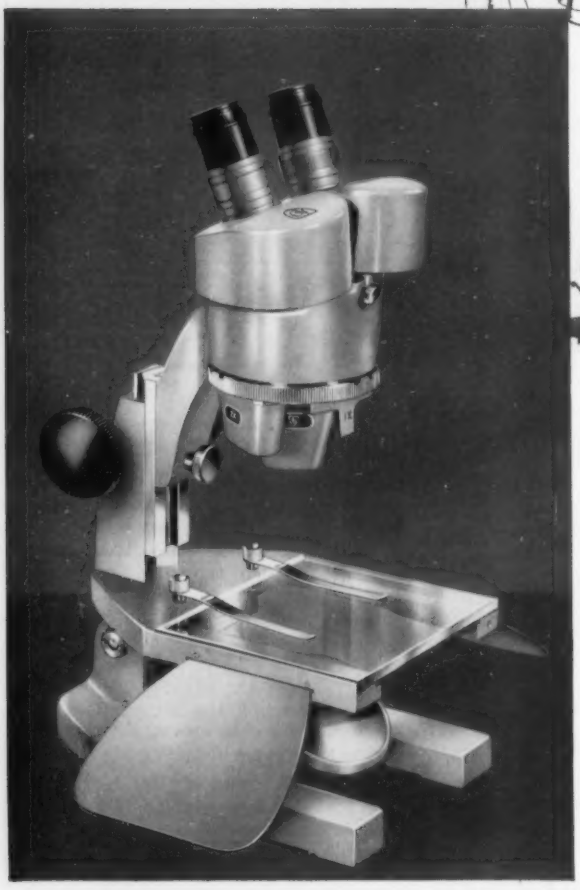
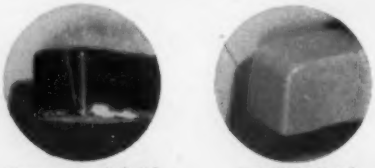


AO Stereoscopic Microscopes have a reputation for optical quality and ability to work smoothly in spite of rough usage. Now, with the addition of the amazing new EPOXY finish, a fine instrument is made even better. EPOXY baked enamel is harder...so hard in fact that it is even being used to replace porcelain for lining hot water tanks. Unequalled metal bonding characteristics along with a remarkable resistance to mechanical impact retains that "new look" almost indefinitely. Most unusual of all — exceptional resistance to chemical deterioration. Look for these AO Stereoscopic Microscopes in the new EPOXY dove-gray color at your dealers now.



Conventional finish *EPOXY finish*

RESISTS CHEMICAL DETERIORATION

The above unretouched photographs show a conventional finish and the new EPOXY finish after a lengthy torture test. Both stands were subjected to a 20% salt spray at 95°F for 538 hours. Conventional finish shows serious corrosion yet the EPOXY finish is completely undamaged. Light line on EPOXY finish is saline residue.

OTHER OUTSTANDING AO FEATURES

- Interchangeable objectives
- Erect 3 dimensional images
- Wide, unusually flat fields
- Easy on the eyes even during extended use
- Dust-proof revolving nosepieces
- Slideways grooved to retain lubricant

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